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REPORT OF
TWENTY-FIFTH ANNUAL
DATE GROWERS' INSTITUTE

APRIL 24, 1948



HELD IN
COACHELLA VALLEY
CALIFORNIA

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The Date Growers' Institute, a non-profit educational organization devoted to furthering the knowledge of date growing, is now in its twenty-fifth year. Proceedings of each Institute have been published, and may be purchased from the secretary individually or in a complete set. An index of the set will be sent on request.

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25th Annual Date Growers' Institute

Saturday, April 24, 1948

Chairman, Morning Session: Knowles A. Ryerson, Ass't. Dean, College of Agriculture, Davis, California.
Chairman, Afternoon Session: T. H. Kearney, U. S. Department of Agriculture (Retired).

INTRODUCTION

Knowles A. Ryerson, Assistant Dean, College of Agriculture, Davis, California.

Mr. Chairman—Friends: It is a pleasure and a privilege to be asked to preside over this session of the Twenty-fifth Annual Date Institute. A twenty-fifth anniversary is always something special—in family affairs it is a silver anniversary—in civic affairs it marks a “quarter century of progress.” In the date industry it is a milestone on a road that has come a long way since its beginning shortly after the turn of the century and the planting of the first palms in the southwest.

While it is unlike other fruit industries in some outward aspects, basically it has followed the same road. Other fruits passed through the seedling era long ago; many of us can still recall that period in the date industry. Production problems—variety, pest and disease control, soil management, irrigation, pruning and problems of marketing now occupy our time as in any other fruit institute. We have some natural advantages in this industry, and some natural disadvantages. No one looking back over the past twenty-five year life of this institute need be discouraged about its future. The spirit of adventure, determination, hard work, and perspiration have brought the industry a long way. The same factors can insure its stabilization as it faces the mature years.

It is especially pleasing to welcome here today one of the “founding fathers” of the date industry who will honor us by presiding over our afternoon session, Dr. Thomas J. Kearney. His studies in Tunis more than forty years ago and the offshoots he collected there helped launch this important industry on its successful career. Dr. Kearney and his associates in the U. S. Department of Agriculture together with alert and energetic growers in this state and in Arizona have been responsible for establishing this old world crop in our modern setting. In celebrating our twenty-fifth anniversary as an institute, we honor them for their part in making this meeting today possible.

Functions of the Marketing Order and the Date Advisory Board

by MAURE SOLT, Manager Date Advisory Board

Since it is the usual custom, in preparing a program, to give the best speaker the last place on the program, I can assure you that whoever was responsible for arranging today's program has placed me in the proper spot.

The subject assigned to me is “Functions of the Marketing Order and the Date Advisory Board.” Before going into the functions of a Marketing Order, I believe we should review, for a few moments, the history, intent and method by which our Marketing Order was established.

Marketing agreement programs which by law could be made applicable to all growers and handlers in an industry were first made available by the Agricultural Adjustment Act of 1933. The programs for regulating marketings authorized by that Act were based upon principles developed during many years of experience on the part of growers and handlers who had sought to improve marketing conditions. Voluntary agreements, developed by industry

groups and designed to benefit an entire industry, provided no means of requiring compliance by all persons, and, as a result, were soon abandoned because of non-compliance by a few individuals.

The Agricultural Adjustment Act authorized the entering into marketing agreements, governing the handling of agricultural commodities, by producers, associations of producers, and processors. In 1935 the Act was amended to provide for the issuance of Marketing Orders to regulate the handling of certain specified agricultural commodities.

Due to the various provisions of the Act there arose a conflict of opinion among several Federal Courts concerning the validity of the Act authorizing marketing agreements. In order to clarify the legal status of marketing agreements, the Agricultural Marketing Agreement Act of 1937 was passed. It re-enacted and amended the marketing agreement and marketing order provisions of the Agricultural Adjustment Act in separate legislation, and

thus removed the technical questions upon which some of the adverse court decisions on the marketing programs had been based.

At present there are numerous U. S. Supreme Court decisions, upholding the validity of the Act. These decisions have upheld the validity of the programs and confirmed the constitutionality of the Marketing Agreement Act under which marketing orders are issued.

During that same year the California Marketing Act of 1937 was passed, the content of which was virtually the same as the Federal Act.

The purpose of marketing order programs for agricultural commodities is to improve and maintain the income and well-being of growers.

The Marketing Order for Dates was established upon the testimony in public hearing and at the request by written assent of you growers and handlers. The first season of operation of the present Marketing Order, as amended, will in a short time, be history. Has it improved and maintained the well-

being of growers? Anyone who answers that it has not is passing hasty judgment. A study of the history of any one of the 27 marketing orders in effect in California today will reveal that the first season of operation was not too different from our first year and yet today the value to their respective industries is beyond the fondest hopes of the originators.

A marketing order program is a long up-hill pull, requiring the co-operation of the entire industry, and not an over-night relief program administered by a few leaders.

Naturally you expect to see results but do not lose sight of the fact that many improvement programs which you put into operation on your ranches produce no visible results for several years.

We believe, however, that we can show some immediate results:

1. A very substantial amount of fruit of undesirable quality was diverted into other channels and did not compete on the market with your better quality fruit. Not all of the undesirable quality dates were diverted, if that were the case the history of our marketing order would be most unique compared to the early years of other marketing orders. The important fact is that some such dates were diverted and that is a step toward the ultimate goal. This would not have been accomplished this year without the Marketing Order.

2. Are you aware of the fact that your Advisory Board is authorized to conduct research into the production, processing or distribution of dates? Your Advisory Board felt that one of the most pressing problems was insect infestation, the loss by which during the past season was estimated conservatively, after much study, at one-half million dollars. Much valuable information has been compiled by your Advisory Board, on this problem, and on April 27th your Board is meeting with the heads of a number of Federal and State agencies, the result of which

we believe will be a highly accelerated program of control. This is a direct result of your Marketing Order.

3. When the annual report of your Advisory Board is promulgated, June 30th, you will see statistical data such as has never before been available to the date industry. These statistics could not have been compiled with as high a degree of accuracy by any other method than through the operation of a Marketing Order.

4. Your Advisory Board is working tirelessly toward new outlets for all grades of dates and against all encroachments on your industry. One phase of this effort will reach fruition in the near future and the value to the industry will be many times over the cost of administering the Marketing Order.

Yes, we believe that we can show you that your industry has benefited by this season's operation of the Marketing Order and when the financial statement of the Advisory Board is rendered at the end of the fiscal period, you will agree that the Marketing Order has been administered economically.

Now that the current season is nearing an end the Advisory Board is not sitting by waiting for the next season but rather is working harder than ever to make the necessary adjustments in the operation to insure the smoothing-out of this season's rough spots.

Plans are being made whereby the inspectors will be properly schooled. Specifications are being studied and adjusted so as to be as nearly mechanical as is practical to insure a higher degree of uniformity of grade. Administrative procedures are being scrutinized with the reduction of the present rate of assessment the objective. The entire Marketing Order is being studied for the purpose of further simplification. New procedures are being established for the purpose of reducing the amount of paper work on the

part of the handlers. A series of meetings is being held with handlers, packing house supervisors and inspectors for the purpose of correlating ideas as to grades. The manager was sent to Fresno for the purpose of making a complete survey of the successfully operated Marketing Order for Figs and a number of simplified procedures will be established as the result.

No group in the date industry has ever worked more tirelessly to improve and maintain the well-being of the growers than your present Date Advisory Board.

During the last week many of you have been in attendance or testified at the public hearing on the proposed Federal Marketing Order. This proposed Order will tend to perpetuate the entire long-range Marketing Order program. If this order is issued, many services of various Federal agencies will be available to the industry. All of these services are available at no cost to the industry, therefore, the rate of assessment will not be increased. Better quality control will be possible on interstate shipments of dates and an increased amount of statistical data will be available to the industry.

The date industry is nationwide in as much as dates are marketed throughout the nation. It does not then follow that your Marketing Order should be confined to the State of California.

In conclusion, I wish to leave you with three thoughts:

1. The Date Advisory Board is not attempting to mould the industry to the Marketing Order but rather is moulding the Marketing Order to the industry.

2. The Marketing Order program is a long-range program for the improvement of the industry and requires the cooperation of everyone—for—

3. Remember the banana—when it leaves the bunch it gets skinned.

Findings of the Omphalia Date Root Rot Survey

by Glenn KenKnight

The Omphalia Date Root Rot Survey was undertaken as a result of reports that date decline is caused by either of two species of *Omphalia*, that it is the most serious disease of date palms in California, and that the fungi can be spread from one orchard to another on date offshoots. It was estimated that about one percent of the date acreage in the Coachella Valley was affected (6). To prevent further spread, a quarantine was recommended (5) and put into practice. I was employed by the State Department of Agriculture to lead a survey to locate sources of Omphalia-free offshoots.

Last year I reported that Omphalia had been found in about 10 percent of all date root samples taken. However, some people expressed the opinion that "the cream had been skimmed" with regard to Omphalia, that considerable sources of Omphalia-free offshoots might yet be avail-

able, and that the survey should continue.

Last year the literature was reviewed briefly and some phases of the problem were discussed (10). These will not be duplicated here.

Diagnosis and the Quarantine

The difficulty of diagnosing date decline from symptoms has been pointed out by all who have investigated the disorder. A severely declined palm resembles an abandoned palm that survives without appreciable growth. If severely declined palms are present, they are usually surrounded by moderately weak ones or by palms that look all right but tend to produce only dry fruit. There are a few moderately weak palms in almost every orchard. In some good orchards there are areas where the palms are far below average. If these orchards received less care, these areas might resemble decline areas. Occasional weak palms

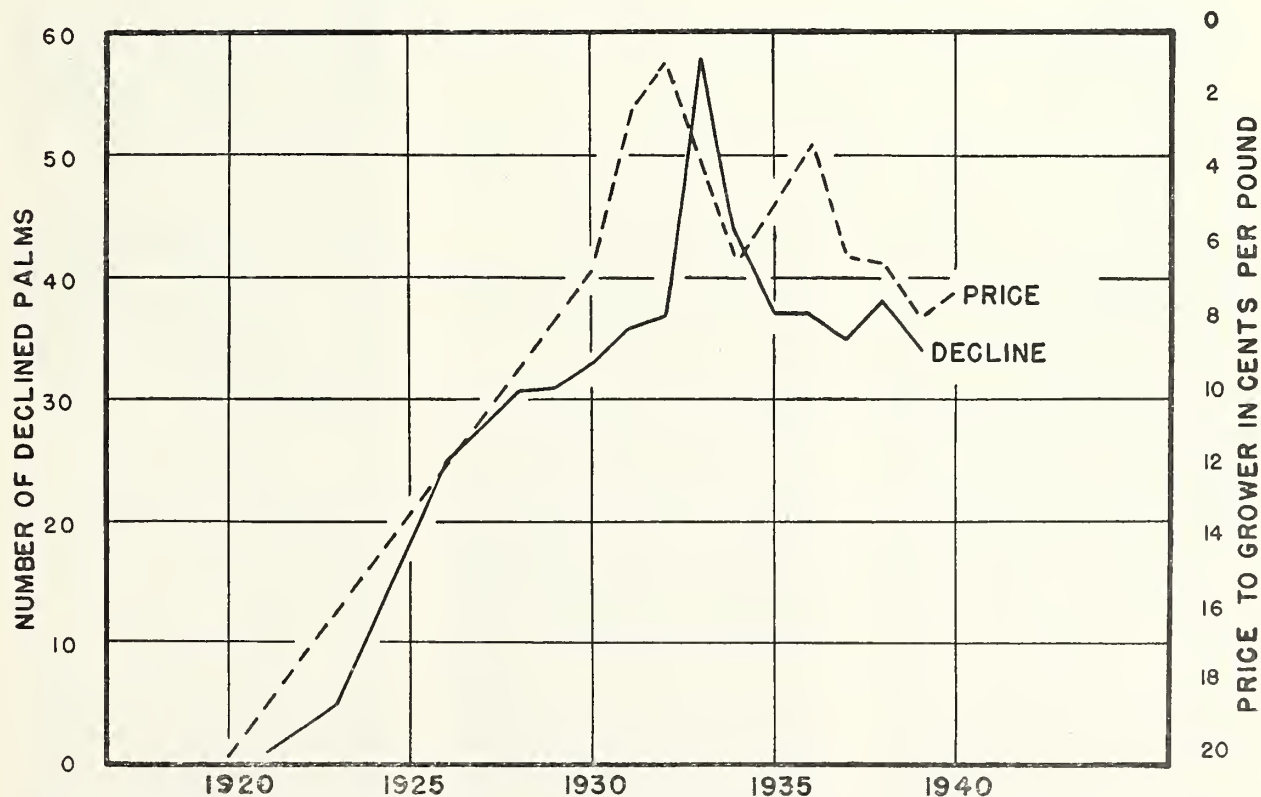
may have arisen from weak offshoots that got off to a slow start, were soon shaded, and so never had a chance to equal their neighbors. Fawcett and Klotz pointed out that decline areas start with one or a few weak palms and spread until definite limits seem to be reached (9).

The isolation of Omphalia has been regarded as the most reliable means of diagnosing date decline (6). However, even from weak palms in the alphabet gardens*, Omphalia has usually been obtained from only a small fraction of the root samples (Table II).

According to the survey outline "After the presence of Omphalia has been established on one or more trees in an orchard, then all the trees in that orchard having typical

*Orchards in which Omphalia had been found prior to the survey were designated by letters of the alphabet (6).

Figure One—Inverse Relation between the Price of Dates and the Number of Declined Palms in the Type Orchard for Date Decline (Garden G)



Data on number of declined palms taken from Hilgardia 16 (2); 74. 1944. Price curve based on graph prepared by W. W. Cook, President, California Date Growers' Association, showing price per pound received by a typical Deglet Noor grower.

TABLE I.
Results of Plating Root Samples

Species	Number of samples	No. yielding <i>Omphalia</i>	percent positive
<i>Phoenix dactylifera</i>	3226	315	10
<i>P. canarensis</i>	54	0	0
<i>P. reclinata</i>	1	0	0
<i>P. sylvestris</i>	10	3	30
<i>Butia bonneti</i>	1	0	0
<i>Sabal texana</i>	2	0	0
<i>Cocos plumosa</i>	22	0	0
<i>Washingtonia filifera</i>	106	0	0
	3422	318	9
DATE PALMS			
Imported Varieties	2923	292	10
Algerian	2435	201	8
Deglet Noor	2397	193	8
Iteema	8	1	15
Rhars	20	7	35
Thoory	10	0	0
Iraqian	321	70	22
Barhee	44	11	25
Halawy	23	7	30
Khadrawy	128	30	23
Khustawy	17	0	0
Zahidi	109	22	20
Egyptian	85	11	13
Hayany	7	0	0
Saidy	78	11	14
Moroccan			
Medjhool	15	0	0
Unclassified			
27 misc. soft	30	4	13
Unidentified	37	7	19
Seedling	305	23	8
female	191	12	6
male	114	11	10

symptoms of the disease may reasonably be assumed to be affected." Thus if *Omphalia* is found in 2 out of 20 root samples in an orchard, all weak palms there may be regarded as *Omphalia*-positive. Two out of 20 is 10 percent. That is the average yield of *Omphalia* from all root samples. With no more than an average yield of *Omphalia*, I hesitated to designate all the weak palms as having *Omphalia* when that decision involved a quarantine taking in nearly half an acre around each infected palm or group of palms, and involved the recommendation that the offshoots (then worth 10 dollars each) on the palms in the quarantine area be killed with stove oil. It seemed necessary to eliminate the possibility that the weakness in a palm might be due to some mechanical injury, inadequate irrigation, poor drainage, poor soil, or some other cause. Progressive decline, spread within an orchard, and

spread by offshoot movement are all attributes of date decline as described, and observations thereon are a part of diagnosis. As a consequence of these observations, no palm was reported as having *Omphalia* root rot unless *Omphalia* was isolated from its roots.

Little attempt has been made to outline infested areas. In some cases *Omphalia* has been found in 5 or 10 percent of the samples from Deglet Noor palms where there had been no reason to suspect any of the palms. It seemed probable that further sampling would give a somewhat similar percentage, and there would be little purpose in sampling all the palms around a known infected palm unless all the other palms were sampled too. The 70 foot quarantine was purely arbitrary. In an earlier recommendation (5) 10 palm spaces was given as the safe distance from which to procure offshoots. That involves 8 acres for

each infected palm or group of palms, and that is near the average size of date orchards in the Coahuila Valley. The purpose of the survey was to find sources of *Omphalia*-free offshoots, and it seemed that this could be accomplished quicker by moving on to another orchard if *Omphalia* was found.

Expansion of Decline Areas

In Garden G the decline area spread from 31 palms in 1928 to 58 in 1933, and decline made its appearance in three other blocks propagated from offshoots from the initial decline block (8). Thereafter the orchard received better care. The small decline areas disappeared, and the original area returned to its old boundary. In Garden V and in some adjoining orchard blocks that were practically abandoned for a time, the margins of the decline areas became indefinite but tended to reestablish themselves when the orchards again received care. In Garden T decline swept through a block in a drought pattern (10). In Garden Q, in both the 1915 and 1923 blocks of Deglet Noor, the palms all show the effect of prolonged neglect, and have made relatively little response to improved care. In the same orchard, decline was reported to have caused considerable damage in the 1928 block (6, p. 80), but, with better care, the decline area has disappeared. This tendency for young palms to recover more readily than old ones is evident also in Garden B. For several years the orchard received very little water. When care was restored, the younger palms recovered, but the palms of the 1915 block still look very weak.

It appears that decline areas in orchards receiving moderate care usually reach definite limits within 8 to 12 years after the planting date. As a result of neglect or abandonment because of low date prices or fear of *Omphalia* root rot, decline may sweep through the entire planting but generally stops abruptly at property lines.

Latent Period

Measurement of duration of latent period has been made only with young palms; it is the time from the date of planting to the appearance of decline symptoms. This is reported to be about 5 to 7 years (6). Actually younger palms also vary greatly in vigor, and some may be chlorotic, but the weak ones begin to look decrepit only after the oldest leaves begin to die and the production of new leaves does not keep pace. A Deglet Noor leaf is said to remain green and useful for about 7 years. Some of the leaves are 2 or 3 or more years old when the offshoots are set out. This seems sig-

TABLE II.

Results of Root Platings from ALPHABET GARDENS

Property		Deglet Noor / x						Other Varieties		Total		per cent yielding Omphalia
No.	Garden	No. Samples Omphalia- Positive	TOTAL	No. Samples Omphalia- Positive	TOTAL	No. Samples Omphalia- Positive	TOTAL	No. Samples Omphalia- Positive	TOTAL	No. Samples Omphalia- Positive	TOTAL	
1	P	15	105	7	35	7	21	4	9	33	170	19
3	(1945)	0	3	0	0	1	15	0	0	1	18	6
19	R	1	6	1	6	0	2	0	0	2	14	7
21	M	1	14	0	9	0	0	0	1	1	24	4
28	(1945)	1	37	2	24	2	19	1	8	6	88	7
49	T	6	11	0	0	1	1	11	24	18	36	50
50	Q	1	16	2	13	3	24	1	14	7	67	10
53	Y Garnet	1	27	0	4	0	0	0	0	1	31	3
62	N	0	8	0	0	0	1	0	0	0	9	0
64	C	1	11	1	3	7	8	0	6	9	28	32
65	X Control Block	0	10	0	0	0	0	2	9	2	19	11
79	G	0	58	0	4	1	8	0	3	1	73	1
88	O	0	3	1	5	1	3	0	8	2	19	11
89	I	1	3	0	0	0	0	1	9	2	12	17
90	W	2	2	0	0	1	2	4	8	7	12	58
91	D	1	17	0	1	0	0	0	0	1	18	6
119	AA	0	4	2	6	1	4	0	0	3	14	21
120	K	0	19	0	5	0	1	0	0	0	25	0
		31	354	16	115	25	109	24	99	96	677	
		9%		14%		23%		24%		14%		

. = healthy

/ = weak

x = very weak

nificant in relation to the duration of the latent period. The relation of amount of irrigation to the latent period was discussed last year (13).

Spread by Offshoots

Offshoots from the type orchard for date decline have an excellent record (10). There are many orchards that were planted in whole or in part from offshoots from orchards where decline exists, but it is not usually known how many or which, if any, of the palms came from palms in or near the decline area. However, there are 100 palms on property No. 8 that came from offshoots from severely declined palms on Property No. 48. At five years of age, these 100 palms look healthy and appear more vigorous than other palms of the same age from other sources planted on this property. The palms in the decline area on property No. 48 came from Garden Z, which in turn had received offshoots from Garden Q.

Orchard Management

The most characteristic symptom of decline is retardation in growth. Aldrich (1) employed growth measurement of Deglet Noor palms as a criterion of adequate water penetration. Fawcett and Klotz observed (9) that decline is less likely to occur in well-kept orchards. In Figure

1 it is shown that the number of declined palms in Garden G, the type orchard for date decline, has varied inversely with cents per pound returns to growers. The implication is that profit and loss have affected the degree of care given the orchard and this has affected the appearance of the palms. The recent owner sunk post holes in the old decline area and struck hard, dry soil,—he was not getting the water down.

Soil

Fawcett and Klotz (9) considered decline to be in some way related to the soil. Although weak palms may be found in orchards on any soil type, about two-thirds of the more-or-less typical decline areas are on Indio very fine sandy loam, about one-fourth on Coachella very fine sand, and the rest on Coachella fine sand (Table IV). However, the significance of this is lessened by the fact that these are the principal soils on which the Deglet Noor variety is grown.

Indio very fine sandy loam: On this soil type occur most of the large decline areas that have received scientific attention, including Gardens G, K, L, N, R, T, Z, and the constellation of decline areas in the vicinity of Martinez. Kocher and Harper (11) point out that local

hard pans occur in this soil type, particularly in the vicinity of Martinez. The spots with hard pan below are never continuous over any considerable area, but occur in patches through the fields.

Coachella very fine sand: With the exception of a part of Garden Z, the decline areas in the high school district are on this soil type. As a rule, the soil appears to be much heavier in the decline areas than where the palms look normal.

Coachella fine sand: Of the many orchards on this soil type, there are large decline areas in Gardens B and C, property No. 78, and in at least one unnumbered orchard. Both B and C, have been inadequately watered in the past, and on C, in the worst decline area, the surface soil appears to have been stripped about 3 feet (six ft. to coarse sand in the good area, 3 ft. to same in decline area; good orchard to south about 3 ft. higher). The owner of property No. 78 considers that the soil in the decline area holds water less well, but is unable to give it supplementary irrigation because of inadequate water supply.

Deglet Noor

From the first the decline disease has been associated with the Deglet

Noor variety, which constitutes about 90 percent of the date plantings in the Coachella Valley. Although other varieties are affected by degree of care, Deglet Noor appears to be one of the most susceptible to drought. It appears that palms of other varieties, although they make poor growth with water shortage, retain their old leaves longer and do not give the appearance of being diseased. In Garden C, there are two Khadrawy palms which have received little water and which at times have been surrounded by lawn. At 15 years of age these palms look like normal palms of 5 or 6 years, whereas the Deglet Noor between them has typical decline symptoms with few and chlorotic leaves (10, table V). In Garden Q, the trunk height measurements of palms in a Zahidi block at 18 years of age varied from 2 to 22 feet. This block adjoins a block of Deglet Noor planted in 1915 where the spread of decline has been studied (6). The severely stunted Zahidi palms have relatively few sound roots, but they retain their leaves and give the appearance of being younger palms.

Association of Omphalia with Decline

Another year of survey has not changed the trend of results previously reported (13). Omphalia has been found in several of the best and in many good orchards in the Coachella Valley.

Pathogenicity

Although Omphalia will dampoff small date seedlings*, most mature date seedlings have been regarded as resistant to decline (6). Omphalia has been found on the Deglet Noor variety in 78 orchards. These 78 orchards may be regarded as experimental plantings to determine how much damage Omphalia does. If Omphalia spreads only by root contact and offshoot movement (6), the finding of Omphalia in an orchard indicates that it has been there since the time of planting, and you have only to estimate the age of the palms to know approximately how long the palms have been infested. Unfortunately, these are experiments without controls, for we are not sure that any orchards are wholly free from Omphalia. The type orchard for Omphalia root rot (Garden D) is one of the most productive date orchards in California.

Root Lesions

Brownish, sometimes sunken, lesions on large roots of declined

*In the greenhouse date seedlings grown in soil infested with nematodes from date roots have been very severely stunted. However, nematodes have not been considered of major importance on mature palms.

TABLE III.

Occurrence of Omphalia and Date Decline in the
ALPHABET GARDENS*

- I. Affected Palms not Removed
 - A. Palms now recovered
 - Garden M: Omphalia from 1 palm, now in fair condition.
 - Garden U: 20 palms regarded as declined 1937. Now in fair condition.
 - Garden G: Decline areas reported in 1944 for Blocks II, III, IV are no longer evident.
 - Garden Q: Disease reported to have caused considerable loss in 1928 block of Deglets. Palms now in fair condition.
 - B. No recent extension of decline
 - Garden N: 17 declined palms, no extension since 1935.
 - Garden G: Block I—Decline spread from 1 palm in 1921 to 33 in 1928, 59 in 1934 (depression), and receded to 37 1947. No permanent spread since 1928.
 - Garden K: 82 declined palms noted 1939, only 45 1947.
 - Garden W: Many weak palms.
 - Garden V: Many weak palms.
 - C. Further extension of decline
 - Garden Q: 1923 block—8 declined palms 1931, 66 1937, 111 1947.
 - Garden Q: 1915 block: 68 1938, 69 1932, 118 1936, 208 1947.
 - Garden Y: (Thermal) one declined palm reported 1943, three very weak and many sub-normal 1946.
- II. Affected palms removed
 - A. Eradication attempted by soil fumigation (3, 7, 8).
 1. Unsuccessful: Extension of decline symptoms after treatment.
 - (a) Omphalia not eradicated
 - Garden O: 6 palms spaces fumigated 1939.
 - Garden B: 1 palm space fumigated 1935.
 - Garden C: North block—15 spaces fumigated 1934.
 2. Only one weak palm and no spread later
 - (a) No further root sampling
 - Garden F: 1 palm space fumigated 1943.
 - Garden J: 1 palm space fumigated 1935.
 - (b) Root samples negative in subsequent sampling
 - Garden E: 1 palm space fumigated 1939 (3 root samples 1947).
 3. A few weak palms and no spread later
 - (a) No further root sampling
 - Garden A: about 6 spaces fumigated 1934-39.
 4. No decline: Khadrawy palms
 - (a) Unsuccessful: Omphalia found on further sampling.
 - Garden I: 3 spaces fumigated 1942

palms have been described and illustrated (6). During the course of the survey, these have been found to be a good source of *Omphalia*. However, as has been pointed out (9), these brown patches occur on the roots of apparently healthy as well as on declined palms, and *Omphalia* is sometimes obtained from less characteristic lesions, especially from necrotic tips of small roots on apparently healthy as well as declined palms (10).

Spread of *Omphalia*

The survey was based on the premise that these species of *Omphalia* are not native to the date growing areas of California, but were introduced from elsewhere. During the survey *Omphalia* has not been found on native flora, although more than a hundred quarts of root samples from native plants have been incubated in moist chambers, and it has not been found on the native fan palm, nor on seedlings of palms of any species outside commercial date growing areas. However, *Omphalia* appears to be fairly prevalent on the roots of seedling date palms in the commercial areas, even when the seedlings are in pure, or nearly pure stands (Table V). It appears likely that *Omphalia* was introduced, probably from Iraq, and possibly from other countries also; it seems evident that *Omphalia* spreads more readily than has been assumed.

The ease of isolation of *Omphalia* from seedlings appears to be related to the stand in which they appear. Desert valley seedlings in pure stand or with Deglet Noor yield *Omphalia* from about 8 percent of the root samples, that is, the same as for Deglet Noor. Seedlings in stands of soft dates (mostly Iraqi varieties) yield *Omphalia* from more than 20 percent of the samples as do the soft dates. No *Omphalia* at all has been obtained from seedlings outside desert valleys.

Date culture in the Coachella Valley began in the southeastern part of the valley near Mecca where soft date varieties have been and are still commonly grown. In that area *Omphalia* is far more readily found than farther to the north and west. This may be partly a matter of variety, but not wholly so. There *Omphalia* is prevalent on seedlings as well as on standard varieties.

In August, 1947, during cool cloudy weather, *Omphalia* mushrooms developed in the greenhouse in abundance. It seems likely that this could happen outside also. *Omphalia* mushrooms have caps the size of a dime or smaller, and wither away in a day or two if not protected in a moist chamber. In the debris or grass at the base of palms,

B. Soil not sterilized

1. Declined palms removed and spaces replanted
 - (a) Replanted palms apparently normal
 - Garden R: about 100 spaces replanted 1938. *Omphalia* still present.
 - Garden S: 18 spaces replanted about 1941. No further sampling.
 - (b) Replanted palms declined
 - Garden P: 7 acres replanted about 1933. Severe decline but much improved with better care.
 - Garden T: 20 Deglet Noor and 20 Khadrawy interplanted in decline area 1933. Deglets declined.
2. Declined palms removed
 - Garden H: Orchard extinct.
 - Garden Z: Further extension of decline.
3. No typical decline symptoms then or later.
 - Affected palms died of rhizosis (rapid decline).
 - Garden D: The type orchard for *Omphalia pigmentata*. *Omphalia* still present.
 - Garden Y: (Garnet) *Omphalia* still present.

*Orchards in which *Omphalia* was found 1930-43. See literature citations 2, 3, 4, 5, 6, 7, 8.

they would pass unnoticed by most people. It is possible that mushrooms have played an important part in the distribution of *Omphalia*.

From the record of the order in which the root samples were taken, one can determine how many samples were required to find the first *Omphalia*-isolate in each orchard. It will be noted that with both soft dates (Table VI) and Deglet Noor (Table VII), the results fall short of expectation based on the hypothesis that the distribution of *Omphalia* is completely random. The deviation of observed from expected is largely due to the tendency of some orchards to yield *Omphalia* readily.

Sources of *Omphalia*-free Offshoots

The finding of *Omphalia* in seedlings does not prove that these species of *Omphalia* are native, but it does indicate that there is no escape from *Omphalia*. In orchards where root sampling has not yielded *Omphalia*, there is no assurance that further sampling would not disclose it even on palms that have been sampled. Sometimes *Omphalia* has been isolated from a second sample from a palm where the first sample was negative, or even from a third sample where the first two were negative. Failure to isolate *Omphalia* from a root sample is not good evidence that it is not there. *Omphalia* produces no spores on its mycelium and does not compete well with other fungi found in decaying date roots. It has been rather puzzling

that different sets of root samples from the same orchard block have sometimes given radically different results. For example, property No. 51 was sampled three times, all samples coming from a thrifty block of Zahidi and Khadrawy. Few samples were taken on each occasion because those varieties usually yield *Omphalia* readily. Although *Omphalia* appeared to be present, it was not isolated in pure culture from any of the first 19 root samples, the longest run of negatives on record where dealing with Iraqi varieties. However, *Omphalia* was obtained from 12 of the next 18 samples.

Omphalia root rot is said to affect seriously only the Deglet Noor variety, while other varieties are considered to be more or less resistant (6). So, for a moment, let us consider only Deglet Noor palms in orchards that have not been seriously neglected, and where decline is not a problem. We have obtained *Omphalia* from about one-third of such orchards in the first ten samples (Table VIII). Of the remainder, nearly half have given one or more *Omphalia* isolates in the next 20 samples. We have exceeded 30 samples with the Deglet Noor variety in only 5 "hold-out" orchards, one of which is on the list by default. It was previously listed as positive, but the positive palm turned out not to be Deglet Noor. These orchards range from fair to very good, but include none of the very best orchards in the valley. We have no assurance that further sam-

pling would not disclose Omphalia.

With soft date varieties Omphalia has been obtained from one or more of the first five root samples in more than half of the orchards sampled.

Omphalia has been found on a total of 78 properties in the Coachella Valley, 5 in the Imperial Valley, 2 in the Borego Valley, 1 in Death Valley, 1 at Riverside, 1 at Yuma, Arizona, and it appears probable that this list could be extended indefinitely. Omphalia has been found on palms derived from every important importation of offshoots from North Africa and Asia Minor (10). It appears probable that Omphalia could be found also on several properties near Phoenix, Arizona, at Weslaco, Texas, and in Palestine, because we know that those plantings came from Omphalia-infested sources. Where, then, should we go to find Omphalia-free offshoots?

Control of Date Decline

Date decline is usually correlated with areas where difficulty is experienced in obtaining water penetration. As suggested by Kocher and Harper (11), holding the water on these areas longer at each irrigation should help the situation. Where old palms are severely declined, it may be uneconomic to attempt to bring them back into production. Several years of good care would be necessary to reestablish a root system, and it seems doubtful that the palms would ever be as good as palms that had never undergone decline. In soils that take water slowly, interplanting with citrus seems inadvisable. Long standing water necessary to irrigate the palms thoroughly will promote gummosis in the citrus.

As pointed out by Bliss, some soft date varieties appear to thrive better in decline areas than does Deglet Noor. The latter does not appear to do well in tight soil. Decline also appears to occur in areas where the soil has a lower water-holding capacity than the rest of the orchard. There, more frequent irrigation for the area in question would seem to be the answer.

Removal of declined palms and replanting to palms should be done only if the grower is prepared to give special attention to irrigation of the decline area. He should make sure that adequate water penetration can be obtained for date culture. If the soil is not suited to Deglet Noor, some other variety or some other crop should be grown.

Conclusions

Omphalia is widespread on the roots of date palms in California. It has been obtained from about 10 percent of all root samples. However, it appears evident that Om-

TABLE IV.
Soil Type in Relation to Omphalia and Date Decline In the Lower Coachella Valley

Soil Type	Properties with large decline areas	Properties sampled	Percent yielding Omphalia	Samples Taken	Percent yielding Omphalia
Superstition Sand	0	1	100	18	6
Coachella Fine Sand	3	16	69	357	12
Coachella Very Fine Sand	8	14	71	561	11
Indio Very Fine Sandy Loam	22	33	61	744	10
Indio Very Fine Sand	0	3	100	70	21
Indio Loam	0	6	83	156	9
Indio Clay Loam	0	2	50	29	24
Indio Clay Loam, Silty Phase	0	4	50	49	8
Indio Clay	0	2	50	31	3
TOTAL	33	81	67	2015	11

TABLE V.
Effect of Location on Results of Plating Root Samples from SEEDLING DATE PALMS

Location	Male Palm Fraction	Male Palm %	Female Palm Fraction	Female Palm %	Average %
Desert Valleys					
Pure stands	2/17	12	9/140	6	7
with Deglet Noor	4/53	8	1/ 18	6	7
with Soft dates	5/22	23	2/ 9	22	23
Upland					
Pure stands	0/22	0	0/ 24	0	0
Totals	11/114	10	12/191	6	8

TABLE VI.
Number of Samples Required to Find Omphalia All "Soft" Date Varieties*

NUMBER OF PROPERTIES						
Sample	Omphalia Found	Negative with no further sampling	Total Considered	% Yielding Omphalia	Accumulated Percentage	Expected % random Dist.
1st	7	7	50	14	14	19
2nd	4	3	36	11	24	35
3rd	3	2	29	10	31	47
4th	3	3	24	13	40	57
5th	5	0	18	28	57	66
6th	1	1	13	8	60	72
7th	1	1	11	9	63	77
8th	2	2	9	22	71	87
9th	1	0	20	6	77	85
12	0	2	4	----	----	92
20	1	0	2	50	89	99
48	1	0	1	100	100	100
	29	21				

*Omphalia was found on Deglet Naar or male palms on six of the properties listed as negative for soft date varieties.

phalia is present on the roots of a much higher percentage of palms. It seems unsafe to assume that any orchard is wholly free from Omphalia. Consequently, in obtaining date offshoots, there seems to be no reason to discriminate against orchards where Omphalia has been found.

The appearance of decline symptoms in date palms may possibly arise from numerous causes. It is most commonly associated with inadequate irrigation or failure to get sufficient water penetration in tight soil. It is possible that the tight soil is unfavorable to the Deglet Noor variety for other reasons than the difficulty of wetting it to a sufficient depth.

Acknowledgments

The project has had its headquarters at the U. S. Date Garden. We are deeply indebted to its staff for these accommodations. Never in my experience have I had better cooperation from growers than here in the Coachella Valley. I thank you all. I wish also to commend my superiors in the Bureau of Plant Pathology, Mr. D. G. Milbrath and Mr. G. L. Stout, for their complete cooperation.

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TABLE VII.
Number of Samples Required to Find Omphalia
DEGLET NOOR
Excluding Seriously Neglected, Abandoned and
Alphabet Orchards

NUMBER OF PROPERTIES						
Sample	Ompholio found	Negative with no further sampling	Total considered	% Yielding Omphalia	Accumulated percentage	Expected % random Dist.
1st	5	5	77	6	6	5
2nd	6	5	67	9	15	10
3rd	3	1	56	5	19	15
4th	4	0	52	8	26	20
5th	1	1	48	2	27	24
6th	1	1	46	2	29	28
7th	2	0	44	5	33	32
8th	0	1	42	....	....	35
9th	0	1	41	....	....	39
10	1	0	40	3	35	42
11	0	1	39	....	....	45
12	1	2	38	3	36	48
13	1	2	35	3	38	51
14	1	2	32	3	40	53
15	0	1	29	....	....	56
16	0	0	28	....	....	58
17	0	3	28	....	....	60
18	0	3	25	0	0	62
19	1	1	22	5	43	64
20	0	3	20	....	....	66
22	3	0	17	18	52	71
23	0	2	14	....	....	72
24	0	2	12	....	....	73
25	0	1	10	....	....	74
26	1	1	9	11	57	76
28	0	1	7	17	64	78
30	1	0	6	....	....	80
35	0	1	5	....	....	85
42	0	1	4	....	....	90
49	0	1	3	....	....	93
59	0	1	2	....	....	96
66	0	1	1	....	....	97
32			45			

TABLE VIII.—Results of Root Platings By Locality.

County	Deglet Noor	Soft	Male	Seedling	Sum
Riverside					
Coachella Valley	184/2298	87/413	10/ 85	12/160	293/2956
Imperial					
Imperial Valley	1/ 7	6/ 74	0/ 2	1/ 15	8/ 98
San Diego					
Borego Valley	4/ 27	4/ 30	1/ 6	0	9/ 63
San Diego & Vicinity	0/ 8	0/ 2	0/ 13	0/ 24	0/ 47
Inyo					
Death Valley	1/ 40	3/ 7	0	0	4/ 47
Yuma, Arizona	3/ 16	..	..	..	3/ 16
Son Bernardino					
Redlands	..	..	0/ 5	0/ 4	0/ 9
	193/2396	100/526	11/111	13/203	317/3236

Insect Infestation and Fungus Spoilage of Dates — Their Relation and Control¹

D. L. Lindgren, D. E. Bliss,² and D. F. Barnes^{3, 4}

In 1946 Bliss (2) reported the use of a new fungicidal dust, Thiomate "19" (a mixture of 5 per cent Fermate and 95 per cent sulphur), for controlling date-fruit spoilage, and also indicated a reduction in the number of nitidulid beetles on dates where fungus spoilage had been nearly eliminated. Bliss and Lindgren (4) found both the number of beetles and the number of beetle-infested fruits to be reduced where the amount of fungus spoilage had been decreased by treatment with Thiomate "19."

The present paper reports investigations during 1947 on insect infestation and fungus spoilage of dates in the Coachella Valley, California. These investigations included experiments with Thiomate "19" and other fungicides, and with insecticides used singly or in combination with fungicides. New information is presented on the importance of sanitation in the control of the nitidulid beetles, and also on the relative abundance of the various species of beetles and moths that infest the dates.

Materials and Methods

The fungicidal and insecticidal dust experiments consisted of six test plots scattered rather widely over the Coachella Valley, as follows: Deglet Noor plots near Indio and Coachella, Khadrawy plots near Indio and Mecca, a Medjhoor plot near Indio, and a Saidy plot at Palm Village. There were 84 fruit bunches in the Deglet Noor plot near Indio and 30 fruit bunches in each of the other plots. The bunches were evenly distributed on all sides of the palms and were of such height as to permit dusting and fruit-picking

operations from the ground or with the aid of a short ladder.

The first dust treatments were applied on July 23, 1947. Some bunches that were dusted prior to the rain of August 8 were redusted after the rain. The Deglet Noor plot at Coachella was dusted twice, first on August 13 and then again on September 17. Nine of the Deglet Noor bunches near Indio were treated twice with the various insecticides used. The experimental dustings were relatively heavy and thorough, more dust being applied to the bunches than in ordinary field-dusting operations. On the Deglet Noor and Saidy varieties, the dusts were applied after the fruit bunches had been covered with paper tubes (bags), or, in the case of the soft dates, just prior to wrapping the bunches with cheesecloth.

Certain date bunches were entirely enclosed in tubes, 33 inches in diameter, made of a fine-mesh, 1.8-ounce cotton marquisette similar to the mosquito netting used by the armed services. These tubes were slipped over the fruit bunches and tied around the fruitstalk and also below the fruitstrands. Some of the tubes were treated chemically by dipping them in solutions of experimental insecticides.

Various fungicidal and insecticidal dusts were applied to the date bunches during the 1947 season (table 4). Thiomate "9" is a mixture of 10 per cent Fermate in sulphur. Zerlate is closely related to Fermate but differs in that the active ingredient, zinc dimethyl dithiocarbamate, contains zinc instead of ferric iron. Three of the many new synthetic insecticides were tested, namely: benzene hexachloride and Hepta-Klor, which contain chlorine; and parathion, which is a thiophosphate. Most of the dust mixtures were compounded in a ball mill in our own laboratories. The wire rings used were of the crimped type described by Bliss and Bream (3) in 1940.

In experiments on insect control by garden sanitation, insecticidal materials were sprayed on the ground where nitidulid beetles were breeding in fallen dates. These insecticides were either dissolved in low-grade kerosene or dispersed in water, and were applied with a knapsack pressure sprayer, both before and after irrigation.

Only those insecticides found to

be toxic to the nitidulid beetles under laboratory conditions were included in the field tests. In tests of insecticidal materials, beetles were allowed to walk on 6-inch squares of cotton cloth impregnated with the various chemicals. The cloth was first soaked in acetone containing 5 or 10 per cent of a certain chemical. The acetone, upon evaporating, left a finely divided deposit of the chemical on all surfaces of the fabric. The beetles, after walking on the treated cloth for a period of 15 or 30 seconds, were placed in a petri dish, and "knockdown" and mortality counts were made at regular intervals. The treated cloth was then placed outside and exposed to the weather, and other tests were made to determine how long the residue on the cloth remained toxic to the insects. Many tests could thus be made in a short time. In the past several years practically all the new insecticides have been tested in this way. Elimination of those materials that had no effect on date insects in the laboratory narrowed the scope of the field work to those compounds that showed the most promise, namely, benzene hexachloride, chlordan, Hepta-Klor, and parathion.

The method of picking and handling the experimental fruit was similar to that used in the 1946 experiments (4), except that each reading of insect infestation was made from a 50-fruit sample collected at random from a fruit bunch at the beginning of a picking (instead of later from fumigated lots of fruit) and securely tied in a new paper sack to prevent escape of the insects. All samples were fumigated with methyl bromide before being examined in the laboratory for infestation, fruit quality, and fungus spoilage.

Results

ENVIRONMENTAL FACTORS. In 1947 the important effects of temperature and moisture on the date-fruit spoilage complex were again clearly indicated. The dates developed more rapidly than usual because of the relatively warm weather throughout the winter and spring months. At Mecca, for instance, the monthly mean air temperatures ranged from 3.0 to 5.0 degrees Fahrenheit above normal during January, February, and March, and from 1.3 to 3.8 degrees above normal during the fol-

(1) Paper No. 584, University of California Citrus Experiment Station, Riverside, California.

(2) University of California Citrus Experiment Station, Riverside.

(3) Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U.S. Department of Agriculture.

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Table 1.—Rainfall Recorded at Palm Springs, Indio, and Mecca, California, July to December, 1947, Inclusive.*

Date	Rainfall, in inches, at—		
	Palm Springs	Indio	Mecca
July 1-31	-----	-----	-----
Aug. 7	0.75	-----	-----
8	0.06	0.09	1.99
10	-----	0.05	0.05
Sept. 19	-----	-----	0.16
20	0.05	0.02	-----
Oct. 12	Trace	Trace	-----
13	Trace	Trace	0.06
14	Trace	0.02	0.04
Nov. 15	-----	-----	0.01
16	-----	0.02	-----
22	Trace	-----	-----
23	-----	Trace	-----
Dec. 2	0.04	0.09	0.03
4	0.26	-----	0.29
5	0.94	-----	0.03
6	-----	0.50	-----
7	Trace	0.40	-----

*Climotological Data, California Section, U.S. Weather Bureau, Vol. 51, 1947.

Table 2.—Average Percentage of Dates of the Four Varieties Infested with Beetles (Nitidulids) and Moths (Pyrалids, *Ephestia* and *Plodia* Spp.) During the 1946 and 1947 Seasons. (100,000 dates cut open and examined.)

Insects	Deglet Naor	Medjhoor	Khadrawy	Soidy
1946				
Nitidulids	10.5	5.3	4.8	7.2
Pyrалids	2.3	5.4	0.9	0.2
1947				
Nitidulids	19.7	2.6	6.0	15.9
Pyrалids	1.0	7.9	0.8	0.7

Table 3.—Percentages of the Four Species of Nitidulid Beetles Found in Dates of Four Varieties in Six Gardens, 1947.

Date Variety and Location of Garden	<i>Corpaphilus hemipterus</i>	<i>Corpaphilus dimidiatus</i>	<i>Uraphorus humeralis</i>	<i>Haptancus luteolus</i>
Deglet Noor:				
Coachella	11.2	88.4	0.0	0.4
Indio	0.4	99.1	0.0	0.5
Saidy:				
Palm Village	13.7	83.5	2.6	0.2
Khadrawy:				
Indio	9.0	85.0	3.3	2.7
Mecca	20.0	74.0	1.0	5.0
Medjhoor:				
Indio	0.0	92.8	7.2	0.0
Weighted average	8.1	90.5	0.6	0.8

lowing three months.⁵ By mid-summer the dates were thought to be 2 weeks ahead of schedule. Precipitation in a storm from August 7 to 10 varied considerably throughout the valley (table 1). There were heavy showers at Palm Village, Coachella, and Mecca, but the most rainfall was recorded at the Mecca weather station. This storm occurred at a critical period, when the earliest Deglet Noor fruit was susceptible both to water injury and to fungus spoilage, and the quality of this fruit was greatly reduced, especially in bunches having poor aeration.

The midseason and late-maturing bunches of Deglet Noor variety were injured in September and early October by excessively hot, desiccating weather. Considerable sunburning of fruitstalks and fruitstrands and premature shriveling of dates resulted, especially on the south and west sides of the palms. Khadrawy dates at Indio were noticeably affected, as were also the more exposed bunches of Deglet Noor dates that were covered with crepe-paper tubes containing 12 to 15 per cent wax. The temperature immediately beneath the paper had apparently risen to such high levels that the fruits on the outer surfaces of the fruit bunches had been killed by heat (sunburned), a type of injury studied recently by Nixon and Reuther (5).

Dry or shriveled dates had little or no fungus spoilage, but those with high moisture content in poorly ventilated bunches were usually much affected. Masses of wet, souring fruit at the center of large, compact bunches, especially of the Khadrawy variety, were found to be the foci for great numbers of nitidulid beetles, as were also dates that had been injured mechanically.

In general, more fungus spoilage and insect infestation were found on the north or northwest side of a palm than on the south side, and during the hottest part of the day the nitidulid beetles seemed to migrate away from the fruit bunches. These trends are attributed to the changing diurnal effects of solar radiation on the relative humidity of the air and on the temperature and moisture content of the fruit.

INSECT INFESTATION AND FRUIT SPOILAGE. The percentage of insect-infested fruit varied from garden to garden, but in general the heaviest infestations were in areas receiving the greatest amount of rainfall. The early-maturing Medjhoor and Khadrawy varieties were not so severely infested with nitidulid beetles as the later-maturing Deglet Noor and Saidy varieties (table 2). This type

(5) Climotological Data, California Section, U.S. Weather Bureau, Vol. 51, 1947.

of infestation appeared to be correlated with the length and season of the harvest, because in 1947 the experimental fruit of Medjhool and Khadrawy varieties was harvested during the 35-day period August 21 to September 25, while that of the Deglet Noor and Saidy varieties was harvested during the 84 days from September 11 to December 4. The infestation of dates by the pyralid moths *Ephestia figulilella* Greg. and *Plodia interpunctella* (Hbn.) occurred principally in the Medjhool plot, where, in 1947, more dates were found to be infested with these moths than with the nitidulid beetles. In the Deglet Noor plots, however, there were 20 dates infested with beetles to 1 infested with moths. Considering the total insect infestation in the four experimental varieties, both in 1946 and in 1947, the greatest damage occurred in Deglet Noor dates, and the least in Khadrawy.

There were four species of nitidulid beetles present in the dates examined during the 1947 season (table 3). *Carpophilus dimidiatus* (Fab.), the corn sap beetle, was found to be the most abundant (90.5 per cent of the beetles were of this

species), with *C. hemipterus* (L.), the dried-fruit beetle, second (accounting for 8.1 per cent). In 1924 Stickney (7) listed *C. hemipterus* as the only nitidulid beetle infesting dates in the Coachella Valley, and even in the early 1930's it was apparently the predominant species (1). Just why *C. dimidiatus* was so much more abundant in 1947 is not known.

The results of applications of the various fungicide and insecticide dusts on the dates for the control of insects were variable (tables 4 and 5), and it is rather difficult to draw any definite conclusions. In general, it can be stated that the application of insecticidal dusts reduced the number of beetle-infested dates to some extent. The initial kill of beetles by the insecticide probably reduced the number of insects in the bunch, but the residual or persistent effect was not long enough to keep the beetles from reinfesting the bunch prior to picking. Temperatures of 100° F., or above, cause these insecticides to lose their effectiveness very rapidly, especially when the finely divided material has been spread thinly over a surface. To control insects on dates effective-

ly, any insecticide should have a prolonged residual effect of 3 or 4 weeks; if the residual effect is shorter than this, weekly applications may be necessary. Such applications are costly and also involve the problem of toxic residues unless the insecticide can be satisfactorily removed from the dates before consumption.

The reduction in insect infestation when various fungicides were applied as dusts was evident during the 1947 season, but, as with the insecticides, the results were not entirely conclusive. Of 30 experiments with fungicidal dusts, all but 2 (in 1 of which a combination of insecticidal and fungicidal dusts was used) showed reduction in the number of beetle-infested dates, and differences in 14 of the experiments were significant. In gardens where the beetle infestation was high (15 to 25 per cent), however, the reduction was not enough to meet the grading standards of the packing-house. The present tolerance for insect infestation is well under 5 per cent, and from tables 4 and 5 it is evident that this tolerance was reached in only a few tests with the Deglet Noor variety. Reduction in beetle-

Table 4.—Effect of Various Treatments on Fruit Quality, Fungus Spoilage, and Insect Infestation of Deglet Noor Dates at Indio, 1947.

Treatment	Total Amount of Fruit (kg.)	Fruit-Quality Rotting (10 = perfect)	Fungus Spoilage (per cent)	Infestation by	
				Pyralid Moths* (per cent)	Nitidulid Beetles† (per cent)
None (control)	123.5	5.2	27.0	1.6	12.3
Thiomate "19"	59.2	5.4	19.2	0.8	7.6
Gamma isomer of benzene hexachloride, 0.75 per cent in Thiomate "19"	43.1	4.6	25.1	0.6	12.3
Zerlate, 5 per cent in sulphur	45.8	5.7	12.5	0.6	6.4
Yellow Cuprocide, 10 per cent in sulphur	56.7	6.3	10.3‡	0.2	3.1§
Hepta-Klor, 0.75 per cent in Thiomate "19"	54.2	5.7	15.8	0.1	6.7
Parathion, 1 per cent	57.8	6.1	18.1	0.2	8.7
Sulphur	61.6	5.9	17.3	1.1	3.7§
Fermate, 5 per cent in Friarite	61.6	5.3	25.4	2.0	14.1
Thiomate "9"	56.7	5.0	13.2	0.9	6.7
Copper-A Compound, 22 per cent in sulphur	51.9	7.0	13.3	1.7	6.4
Wire ring	48.7	5.8	19.8	1.9	8.0
Wire ring and Thiomate "19"	38.0	6.9	6.9§	0.1	4.1‡

*The raisin moth, *Ephestia figulilella* Greg., and the Indian-meal moth, *Plodia interpunctella* (Hbn.), both of the order Lepidoptera, family Pyralidae.

†*Carpophilus hemipterus* (L.), *C. dimidiatus* (Fab.), *Urophorus humeralis* (Fab.), and *Haptoncus luteolus* (Er.), all of the order Coleoptera, family Nitidulidae.

‡Significant at the 5 per cent level, as shown by the "t" test (6).

§Significant at the 1 per cent level.

Table 5.—Effect of Various Treatments on Fruit Quality, Fungus Spoilage, and Insect Infestation of Four Varieties of Dates of the Crop of 1947.

Location of Garden and Treatment Used	Total Amount of Fruit (kg.)	Fruit-Quality Rating (10 = perfect)	Fungus Spoilage (per cent)	Infestation by	
				Pyralid Moths (per cent)	Nitidulid Beetles (per cent)
Khadrawy					
Indio:					
None (control)	51.2	5.5	3.7	1.3	5.5
Thiomate "19"	49.4	5.9	7.3	4.2	3.0
Gamma isomer of benzene hexachloride, 0.75 per cent in Thiomate "19"	50.8	6.5	3.8	2.1	1.0*
Zerlate, 5 per cent in sulphur	64.5	6.4	2.3	2.1	1.2*
Yellow Cuprocide, 10 per cent in sulphur	60.1	6.4	4.4	2.3	1.8
Mecca:					
None (control)	38.5	6.1	5.7	0.2	6.6
Thiomate "19"	33.1	7.1	2.7	0.6	0.7**
Gamma isomer of benzene hexachloride, 0.75 per cent in Thiomate "19"	36.2	6.4	0.9**	0.1	0.2**
Zerlate, 5 per cent in sulphur	34.6	6.6	3.4	0.3	1.7*
Yellow Cuprocide, 10 per cent in sulphur	34.2	6.4	1.9*	0.2	0.2**
Medjhool					
Indio:					
None (control)	49.2	6.3	5.2	7.9	2.6
Thiomate "19"	36.4	6.6	3.3	0.5	0.6
Gamma isomer of benzene hexachloride, 0.75 per cent in Thiomate "19"	51.2	6.1	7.4	0.7	1.2
Zerlate, 5 per cent in sulphur	38.5	6.1	3.4	0.4	0.7
Yellow Cuprocide, 10 per cent in sulphur	47.0	6.4	4.1	0.7	1.1
Deglet Noor					
Coachella:					
None (control)	45.0	6.5	12.5	0.4	27.1
Thiomate "19"	50.5	5.9	8.9	0.0	11.7*
Gamma isomer of benzene hexachloride, 0.75 per cent in Thiomate "19"	47.4	6.1	13.2	0.1	16.7
Zerlate, 5 per cent in sulphur	48.9	5.7	11.7	0.3	16.3
Yellow Cuprocide, 10 per cent in sulphur	44.9	6.6	15.1	0.3	14.1
Saidy					
Palm Village:					
None (control)	52.8	5.3	26.2	0.7	15.9
Thiomate "19"	46.6	5.9	12.5*	0.0	4.0**
Gamma isomer of benzene hexachloride, 0.75 per cent in Thiomate "19"	49.0	4.3	13.7**	0.0	3.5**
Zerlate, 5 per cent in sulphur	39.2	5.6	13.1**	0.1	5.2*
Yellow Cuprocide, 10 per cent in sulphur	54.1	5.6	10.1**	0.2	1.0**

*Significant at the 5 per cent level.

**Significant at the 1 per cent level.

infested fruit of the Khadrawy variety was significant in 6 out of 8 experiments, however, and the final infestation was well below the 5 per cent tolerance. The reduction in the number of beetle-infested Saidy dates was significant in all 4 experiments, and the percentage of infested fruit at the time of picking was below the 5 per cent level, although almost 16 per cent of the untreated dates were infested. The reason why such efficient control of the beetles was obtained with the Khadrawy and Saidy varieties, but not with the Deglet Noor, is not known. In no case did the application of insecticidal or fungicidal dusts significantly reduce the number of fruits infested with pyralid moths.

The question arises as to whether the various fungicidal dusts act as insecticides; that is, whether they have a direct toxic or repellent effect on the insects, or whether their action is indirect, the reduction in fungus and bacterial spoilage making the dates less attractive to the insects. The nitidulid beetles that are found in dates are primarily scavengers, feeding generally on souring or fermenting dates or on any type of decaying plant material that is available. Especially in Khadrawy, the greatest number of beetles were found in those bunches in which the dates had been mashed mechanically by a leaf stalk, or where masses of sour dates occurred at the center of large, tight bunches. Since the beetles were principally attracted to sour or fermented dates, and not to sound dates, it appears probable that the beetle infestation was reduced indirectly by preventing fungus spoilage and thus making the dates less attractive to the insects. A few spoiled dates in a bunch attracted many beetles. During the 1947 season, insect infestation in dates was reduced significantly in 14 experiments, and the percentage of fungus-infected fruit was reduced significantly in 8 of these. In every case in which fungus-infected fruit was decreased significantly by the use of fungicidal dusts, the number of beetle-infested fruits was also reduced. This indicates a positive correlation between the degree of fungus spoilage and that of insect infestation.

FUNGUS SPOILAGE. Since fungus spoilage (calyx-end rot, side spots, souring, etc.) is now considered largely responsible for attracting the nitidulid beetles into the fruit bunches, there is additional reason for combating it. The results of the fungicidal experiments in 1947, although not so clear-cut as those of previous years (2, 4), demonstrated again that substantial amounts of dates may be saved by such treatments (tables 4 and 5). The use of

Yellow Cuprocid in sulphur gave significant differences in three test plots, but its desirability was questioned because of a black, unsightly residue left on the ripened fruit. In the Deglet Noor plot near Indio, Zerlate in sulphur, Thiomate "9", and Copper-A Compound in sulphur also showed promise (table 4). Fungus spoilage was controlled most effectively, however, where wire rings had been inserted between the fruit-strands and the fruit had been dusted with Thiomate "19". Since, in the other test plots (table 5), treatment with Thiomate "19" was usually as effective as that with Zerlate in sulphur, or slightly more effective, there is reason to consider Thiomate "19" the most satisfactory fungicide of the group.

NETTING EXPERIMENTS. In the netting experiments designed to exclude insects from the fruit bunches, the beetle infestation was reduced to 2 per cent or less, or, under some of the nets treated with benzene hexachloride, was entirely eliminated. Although the chemical treatment was very effective against the beetles, it was not satisfactory because of the disagreeable taste imparted to the dates that touched the nets. Somewhat variable results were obtained with the untreated netting covers, but a reduction in beetle infestation was apparent. It is believed that in most cases the covers were put on too late, many insects being present in the bunches before the covers were installed. An advantage to covers tied at the bottom was that none of the dates dropping from the bunch could reach the ground; they were caught in the net and destroyed at the time of picking. This prevented any build-up of beetles in the dates that would normally have fallen to the ground.

GARDEN SANITATION IN INSECT CONTROL. Observations made during the past three years (1945-1947) indicate that the principal increase in beetle populations in the date gardens occurs in the dates that drop to the ground and remain there to decay. This condition is ideal for the development of the beetles for the following reasons: (a) because dates moistened by irrigation water soon begin to decay and provide favorable feeding conditions; (b) because the immature stages of the beetles cannot survive desiccation; and (c) because the beetle larvae, which pupate only in the soil, can pass from the date to the soil with an almost certain chance of survival. During the past three seasons the relation between beetle population in the soil and date overlay has been observed many times. No insects were found in soil having no dates present on the surface, whereas many were found where the overlay

of decaying dates was heavy.

A series of experiments was started in 1947 to determine whether the overlay of dates could be sprayed with an insecticide that would kill all the insects present on and in the dates and prevent any infestation from building up in these dates for a 3- or 4-week period. Chlordan, benzene hexachloride, and parathion were tested, but benzene hexachloride dissolved in kerosene appeared most promising. Heavily infested dates were spread on 2-foot squares in several experimental plots. One group of plots was irrigated, the other group was kept dry. Each group consisted of a control plot, a kerosene-sprayed plot, and three plots sprayed with kerosene containing different amounts of benzene hexachloride. On the day following treatment the plots were checked for initial kill of insects. In those plots sprayed with kerosene containing benzene hexachloride, the ground was covered with dead beetles and larvae; in the plot treated only with kerosene, very few dead beetles were present; and in the control plot no dead insects were found. Data were recorded in each of the following 4 weeks. In the control and kerosene-sprayed dates, the beetles had continued to develop and to increase to such an extent that after 4 weeks there was little left of the dates. In the adjoining plots that had been treated with kerosene and benzene hexachloride, the dates had not become reinfested, and only three or four living adult beetles were observed. These beetles had probably just flown onto the dates. Benzene hexachloride in kerosene had thus killed practically all the beetles present, and had prevented the dates from becoming reinfested during a period of 4 weeks.

Large experiments involving entire date gardens are planned for the coming season. These gardens are to be treated to determine just what effect control of the beetle development in dates on the ground will have on the beetle population in general, and particularly on the beetle population present in the bunches.

Strict garden sanitation involving the entire agricultural area of the Coachella Valley may be the solution to the beetle problem. Cleaning up all breeding places in the orchard, especially early in the season, is thought to be an important step toward reducing the insect population. At temperatures above 80° F. the nitidulid beetles require only from 2 to 3 weeks to complete their life cycle. The mean average air temperature at Indio is 87° during June, 92° during July, and 91° during August. This indicates that where dates are lying on the ground

4 to 6 generations of beetles can develop from June to fruit harvest. Since one female beetle is capable of laying 500 eggs, a tremendous population of beetles may result even from a single pair of individuals during a period of two or three months. Observations indicate that the population of beetles is very small in the orchard in May, but that it increases with the appearance of the first "June drops." Discing the fallen dates into the soil does not control the beetles because the larvae in the infested dates will pupate in the soil and emerge as adults. If all the fallen dates, starting with those of the first "June drop," could be picked up or treated so that the insects could not develop in them, it would aid in reducing the population of beetles. The greatest build-up of beetles occurs in the dates on the ground, and from there the beetles are attracted to the fruit bunches. Fruit losses could be reduced by efficient and rapid fumigation of ripened dates soon after picking. This would also tend to eliminate the possibility of reinfestation of other picked dates and prevent beetles from migrating back into the garden.

Furthermore, the dumping of fruit and garbage into open pits should be avoided, especially in the late spring and summer, since in the Coachella Valley the nitidulid beetles also feed on grapefruit, sweet corn, pomegranates, figs, tomatoes, and grapes. These hosts are believed to carry the beetles over in large numbers during the winter, spring, and early summer, when there is little food for the insects in the date garden. Sanitation, therefore, is now considered to be one of the principal means of reducing the potential population of nitidulid beetles in dates.

Summary

Four species of nitidulid beetles,

Carpophilus hemipterus (L.), *Carpophilus dimidiatus* (Fab.), *Urophorus humeralis* (Fab.), and *Haptoncus luteolus* (Er.), of which individuals of *C. dimidiatus* represented 90.5 per cent of the total, and two species of pyralid moths, *Ephestia figulilella* (Greg.), and *Plodia interpunctella* (Hbn.), infested the fruit of the four date varieties in the six experimental plots of these studies in 1947. The early-maturing Medjool and Khadrawy varieties were not so severely infested with beetles as the later-maturing Deglet Noor and Saidy varieties. Medjool dates were principally infested with pyralids, whereas in the Deglet Noor variety, there were 20 beetle-infested fruits to 1 containing moth larvae.

Applications of insecticidal dusts to date fruit bunches did not give satisfactory control of either nitidulid beetles or pyralid moths. The beetles, being scavengers and attracted to spoiled fruit, were less destructive, however, because of the indirect action of fungicidal dusts. These fungicides, by reducing fungus spoilage, made the dates less attractive to the beetles, and where fungus spoilage was decreased significantly by the use of fungicides, the number of beetle-infested fruits was also reduced. A positive correlation was found between the degree of fungus spoilage and that of insect infestation.

In the Deglet Noor plot near Indio fungus spoilage was controlled most effectively by inserting wire rings between the fruitstrands and dusting the dates with Thiomate "19". In the other experimental plots Thiomate "19" was preferred to either Zerlate in sulphur or Yellow Cuproside in sulphur. In general, more fungus and insect spoilage occurred on the north or northwest side of a palm than on the

south side.

Tubes of porous cloth (netting) tied above and below the fruit bunch were quite effective in excluding insects from the dates and in preventing detached dates from falling to the ground.

Garden sanitation and the importance of preventing the nitidulid beetles from breeding in fallen dates are stressed. Benzene hexachloride in kerosene sprayed on fallen dates not only killed the beetles but also prevented reinfestation of the dates during a 4-week period. The removal of all known food sources, such as garbage and decaying fruits and vegetables, during the winter, spring, and early summer, when very few dates remain in the orchard, is considered to be one of the principal means of reducing the potential population of nitidulid beetles in dates.

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A Winter Among the Date Palms of Tunisia

by Thomas H. Kearney

In the fall and winter of 1904-05, the writer was sent by the U. S. Department of Agriculture to the Jerids oases in Tunisia to study date culture there and select promising varieties for introduction into the United States. The trip was made at the suggestion of Dr. Walter T. Swingle, who had made similar studies in the Oued Rirh oases of Algeria.

The journey from Tunis, the capital of the French Protectorate, was made by railway and bus to Sfax, the seaport of southern Tunisia, thence by rail westward to Metlaoui, the site of rich phosphate mines, and the last 35 miles on muleback to Tozeur, the capital of the Jerid.

The oases, four in number, are strung out along the base of the low escarpment which here forms the northern limit of the Sahara Desert. Numerous large springs, gushing out from the base of this rampart, furnish the water supply of the oases. To the south lies the Chott el Jerid, an extensive shallow salt lake or playa, similar to the Salton Sea of California before it was inundated by the Colorado River. It is one of a chain of such lakes that extend from the Oued Rirh in Algeria to the eastern coast of Tunisia.

The Jerid and the Oued Rirh are only about 150 miles apart and are very similar in climate and soil. But instead of the large orchards of Deglet Noor dates, planted in straight rows and regularly spaced, established by French enterprise in the Oued Rirh, the Jerid oases, at the time of my visit, were more like gardens, containing many varieties of palms all mixed together, in no regular order and interspersed with other fruit trees and small patches of alfalfa and garden vegetables.

The date harvest was in full swing when I arrived, late in Oc-



tober. The next six weeks were busy ones—making daily visits to the gardens, tasting and noting the characters of the fruits, collecting samples, and photographing the fresh dates.

It was estimated that the less than 20,000 acres of the oases then contained from ½ million to 1 million palms, of which only about 35,000 were Deglet Noors, the rest being of not less than 100 named varieties. These showed enormous diversity in shape, size, color, texture and flavor, from the hard dry dates that form the staple food of the oasis-dwellers and the nomadic Arabs of the desert, to very soft syrupy fruits that must be eaten almost as soon as they are harvested, and are served only as dessert.

Samples of fruit of 93 varieties and natural size photographs of 85 varieties were obtained. These, with

field notes on the palms and fruits, afforded a basis for selecting varieties that seemed best worth introducing into the United States. It was finally decided, however, to try to get offshoots of as many varieties as possible, on the chance that some which seemed second-rate in their home might prove better adapted to California conditions.

After being absent several weeks in other parts of Tunisia and in Sicily, studying olive and pistachio culture, I returned to the Jerid in February. Then began a feverish ransacking of the oases in search of offshoots. Much chaffering was necessary, since owners of palms of the better varieties were reluctant to sell, having heard of the likelihood of California competition in their only industry. A special effort was made to get offshoots of the Menakher variety, a very large date of fine flavor, said to have been reserved formerly for the table of the Bey of Tunis, but only 9 offshoots could be obtained. These were surrendered only under pressure from the Caid of Tozeur, who was very cooperative throughout.

About 700 offshoots, representing 56 varieties, were finally assembled. These were wrapped in liff (palm fiber) after plastering the butt ends with puddled clay, and were then ready for the first stage of their journey. A caravan of 90 camels conveyed them from Tozeur to the railhead. At Sfax they were transferred to a small coastal ship, which carried them to Algiers. There they were repacked in heavy wooden cases for the long voyage to New York and across the continent. A few weeks later I had the pleasure of seeing them unpacked in the old government date orchard, at Mecca, California.

Progress Report on The Development of *Omphalia* Root Rot In Artificially Inoculated Date Palms¹

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The death and rotting of date roots resulting from the attack of *Omphalia* spp.³ have been demonstrated many times (2). These primary symptoms of omphalia root rot have been induced experimentally both in seedling date palms three months to three years of age and in orchard palms of named varieties one to thirteen years of age. In young seedlings the secondary symptoms of omphalia root rot (rapid wilting and death of leaves and stunting or death of the top) are easily demonstrated within a few weeks from the time of inoculation, but in well-established orchard palms the appearance of secondary symptoms (premature wilting and death of the older leaves, an unnatural yellow-green cast of the leaves, retardation in terminal growth, weak fruitstalks, and small, worthless fruit) requires a much longer period.

Such was our experience at the Mecca plot, a 4-acre experimental date orchard situated 2 miles west of Mecca, California. This plot was established in 1934 on a part of a farm which some years previously had been condemned and quarantined because of an infestation of camel's thorn (*Alhagi camelorum* Fisch.). After the land had been cleared and fenced, it was planted with supposedly healthy offshoots of 18 varieties of date palm (*Phoenix dactylifera* L.), and with seedlings of native fan palm (*Washingtonia filifera* Wendl.). The date offshoots were obtained from eleven orchards

in the Coachella Valley of California, and from a nursery of Medjool palms near the southern point of Nevada. The fan-palm seedlings were transplanted from the nursery of the University of California Citrus Experiment Station, Riverside. The young palms were planted in orchard formation in two nearly identical blocks which were separated from each other by an unplanted, nonirrigated strip of land 60 feet wide. More than half the area of each block was planted with palms of 6 important commercial date varieties (10 palms each); the rest of the space was given to palms of 12 other varieties (1 to 5 palms each) and to the native fan palms.

The entire orchard, now (in 1948) in its fourteenth year, has been cultivated, fertilized, irrigated, and fruited in a manner comparable to that employed in the better commercial orchards. The palms have developed under reasonably uniform environmental conditions, the principal exceptions being an area of unusually salty soil across the eastern end of the north (control) block and a gradual decrease from west to east in the amount of irrigation water supplied.

The Mecca plot was established principally for the purpose of studying the relative susceptibility of date varieties to omphalia root rot. It is the purpose of the present paper to report the progress of the disease and especially to record the appearance of secondary symptoms in two of the inoculated Deglet Noor palms. A tentative rating of the relative susceptibility of the 18 date varieties is also proposed.

Procedure

The experimental palms at the Mecca plot were well established and appeared to be in a favorable condition of growth in May, 1938, when differential inoculations were made. Two shallow pits were dug, one on the east side and one on the west, near the trunk of each palm so that the upper primary roots were exposed. A few roots were cut inadvertently, but care was taken to avoid serious injury. The palms in the upper block at the north side of the plot were reserved as controls. Each control palm received 650 ml. of sterile Pillsbury's bran. In the south block, two palms each of the Zahidi, Saidy, Theory, Deglet

Noor, Khadrawy, and Halawy varieties were inoculated with 650 ml. of bran on which *Omphalia pigmentata* had been grown. Each of the remaining palms in the south block received an equal amount of bran on which *O. tralucida* had been grown. The inoculum was chopped and applied both to the bottom of the pits and to the underground surfaces of the trunk. To prevent drying, the pits were filled immediately with soil and covered with straw.

The height of the trunk, the comparative level of health, and the number and size of the fruitstalks and offshoots of each palm were noted in 1938, at the beginning of the incubation stage, and annually thereafter. Root samples from representative palms in both blocks were also cultured at various times to study the progress of the disease, and the fungus isolates that resembled *Omphalia* spp. were tested for pathogenicity on potted seedlings of Deglet Noor dates in the greenhouse.

An intensive survey of the condition of the roots of every palm in the Mecca plot was started in December, 1947. Root samples were obtained from holes that were dug on the north side of the palms 12 inches from the trunk and uniformly 15 inches square (fig. 1). A few sam-



Fig. 1—Sample of primary date roots taken from 15-inch-square sampling hole on north side of palm trunk. The lath frame had been used before digging to mark the position, size, and shape of the area to be excavated.

(1) Paper No. 586, University of California Citrus Experiment Station, Riverside, California.

(2) The writers wish to express their appreciation to the many date growers, scientific workers, and governmental agencies that have contributed to this inoculation experiment, especially to Robbins Russell and the late B. S. Beyer for locating the plot near Mecca, California; to the Supervisors of the County of Riverside for providing both land and irrigation water; to the Staff of the U. S. Date Garden and of the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, for plant materials and pumping equipment; and to L. D. Batchelor, H. S. Fawcett, George H. Leach, Herbert N. Leach, Calvin E. Bream, Howard Jennings, and Albert L. Leap, of the University of California Citrus Experiment Station, for technical advice and assistance.

(3) *Omphalia pigmentata* Bliss and *O. tralucida* Bliss.

pling holes were located on either the northeast or the northwest side, because other sampling holes had recently been made on the north side. The roots were cut along the vertical sides of the hole by means of an offshoot chisel. Care was taken to cut and remove the root segments with as little mechanical injury as possible. Forty or more segments of primary roots were taken as a sample from each palm. The field records included the depth of each sampling hole and also the number of root segments in each sample showing either partial or general necrosis. These necrotic segments were taken to the laboratory, where, after surface disinfection with a solution of mercuric cyanide, tissue cultures were planted on cornmeal-agar slants. The fungi which grew from these pieces of roots were examined both macroscopically and microscopically. All isolates resembling *Omphalia pigmentata* or *O. tralucida* were further identified by cultural tests on glucose potato agar and were tested for pathogenicity on potted date seedlings (2).

Experimental Results

Examination of the roots of representative palms at the Mecca plot revealed that within four months after inoculation primary symptoms of omphalia root rot had developed in all the 18 varieties of date palms, and also in the fan palms. No evidence of omphalia was discovered at that time in any of the control palms that were sampled. In the inoculated palms, however, large, typical lesions were found commonly, and numerous large root segments were generally necrotic. This indicated that all the principal commercial date varieties in California were somewhat susceptible to the disease under those conditions. No visible distress (decline) was evident in the tops at that time, however, and none was detected until 1944.

It was recognized at the time of inoculation that most of the palms in the south (inoculated) block were larger and more vigorous than those in the north (control) block. In 1938 the palms in the inoculated block, in comparison with those in the control block, were visibly superior in 13 varieties, equal in the Medjhoor variety, and inferior only in the Sayer, Tazizoot, and Iteema varieties. These differences were associated with the very saline soil at the east end of the control block, where growth was poor, and with the less saline soil in the other parts of the orchard, where growth was more rapid. In 1947 the situation was generally the same except that only in the Zahidi, Barhee, Khalasa, Hellali, and Maktoom varieties was the relative vigor (growth rate) of

the palms in the inoculated block still distinctly superior to that in the control block.

The mean growth rate of the Deglet Noor palms in inoculated and control blocks is of special interest (fig. 2). From May, 1938, until

vious differences between the control and the inoculated Deglet Noor palms. Whereas the 10 control palms had relatively green, strong leaves, one half of the inoculated palms (Nos. 2, 3, 4, 5, and 7, row 12) had yellowish, weak leaves.

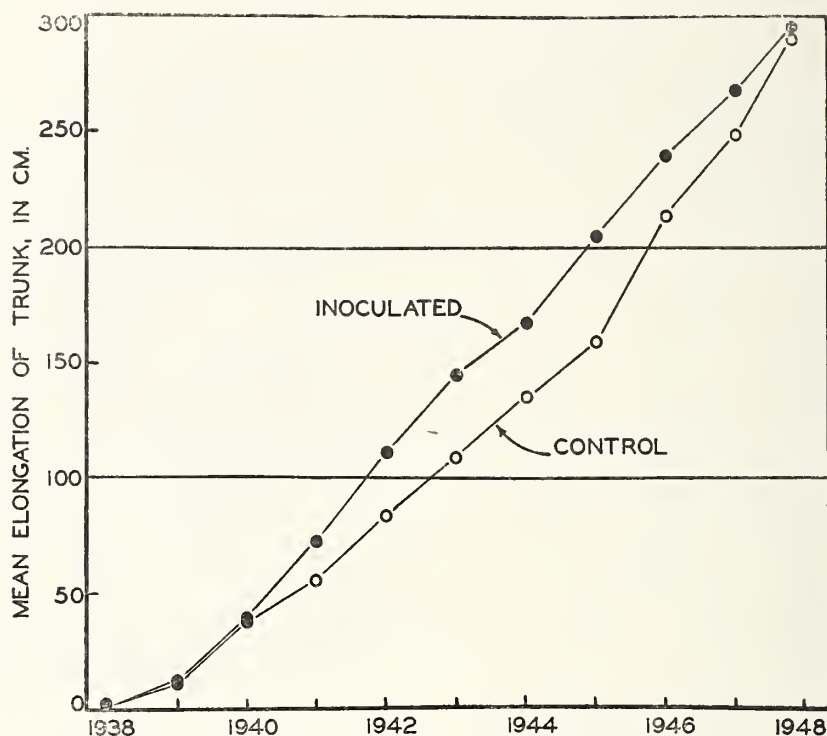


Fig. 2.—Mean elongation of trunks of Deglet Noor date palms in the inoculated and control blocks of the Mecca plot, 1938-1948.

1940, the mean elongation of trunks was about equal in both blocks. The mean growth rate of the inoculated palms then remained nearly constant, while that of the control palms lagged for a period of five years and then became considerably more rapid. In April, 1948, the mean total elongation of trunks in the two groups was about equal, and if present trends continue the control palms will soon surpass the others.

The first indication of secondary symptoms of omphalia root rot was observed June 1, 1944, when, according to the notes, inoculated Deglet Noor palms Nos. 2 and 3 in row 12 showed yellowish, open tops, "the first evidence of decline." Since 1945, these palms have been rated as showing the secondary symptoms of omphalia root rot, palm No. 3 being the weaker of the two. These observations were based on characters which are generally associated with vegetative vigor, such as number and size of green leaves, color of leaf bases, number and size of spathes, rapidity of fruitstalk elongation, and amount of annual trunk elongation.

On April 12, 1948, there were ob-

There were 123 spathes in evidence on the control palms and only 92 on the inoculated (table 1). A close estimate of fruitstalk length from the fiber line of the subtending leaf base to the first or proximal fruitstrand indicated an average of 48 cm. for the fruitstalks on the control palms and only 33 cm. for the fruitstalks on the inoculated palms.

The intensive root survey which was started in December, 1947, revealed that 8 palms in the control block and 29 palms in the inoculated block were infected with *Omphalia* spp. (figs. 3 and 4). Isolates of *O. pigmentata* were cultured from 6 of the 12 palms which had been inoculated with this fungus, but no evidence of *O. tralucida* was detected. All other isolates of *Omphalia*, from either the control or the inoculated blocks, were identified as *O. tralucida*.

All the date-root segments showing partial or general necrosis from any cause were counted and tested for the presence of *Omphalia*. One or more dead roots were found on 40 per cent of the control palms and on 57 per cent of those inoculated. *Omphalia* was cultured from 14 (18 per cent) of the 77 necrotic roots

taken from the control block and from 90 (43 per cent) of the 207 necrotic roots taken from the inoculated block. Among the other microorganisms in the cultures were species of *Fusarium*, *Trichoderma*, *Rhizoctonia*, *Penicillium*, *Aspergillus*, *Helminthosporium*, and *Mucor*, as well as various bacteria, Protozoa, and nematodes. *Fusarium*, the most

common of this group, was cultured from 53 per cent of the necrotic roots from the control block, and from 29 per cent of those from the inoculated block.

Of the six major varieties, Deglet Noor, Zahidi, and Thoory were the ones affected most severely with rotting roots, statistically significant differences being found in each case

between the inoculated and control palms (table 2). Of the minor varieties, Medjhool, Hayany, and Hellali were the ones principally affected. These varieties also yielded the largest numbers of omphalia isolates, except for Medjhool, which yielded none.

In percentages of necrotic roots, the important Khadrawy and Halawy varieties showed no important differences between inoculated and control blocks. *Omphalia* was found, but little damage had resulted. No evidence of *Omphalia* was found in any of the root samples from Iteema, Khalasa, or Tazizoot palms, and the percentages of necrotic roots were negligible.

Since the holes made for sampling the roots were uniform in cross section and in distance from the trunk, data representing the depth of the holes and the total number of root segments taken from each were used to calculate the density of roots in the first 40 to 70 cm. of soil. The differences between groups of palms in the control and inoculated blocks did not all run in one direction, but in the Deglet Noor variety a significant difference was found: whereas the control palms had 1.27 primary roots per centimeter, the inoculated palms had only 0.82 (table 2).

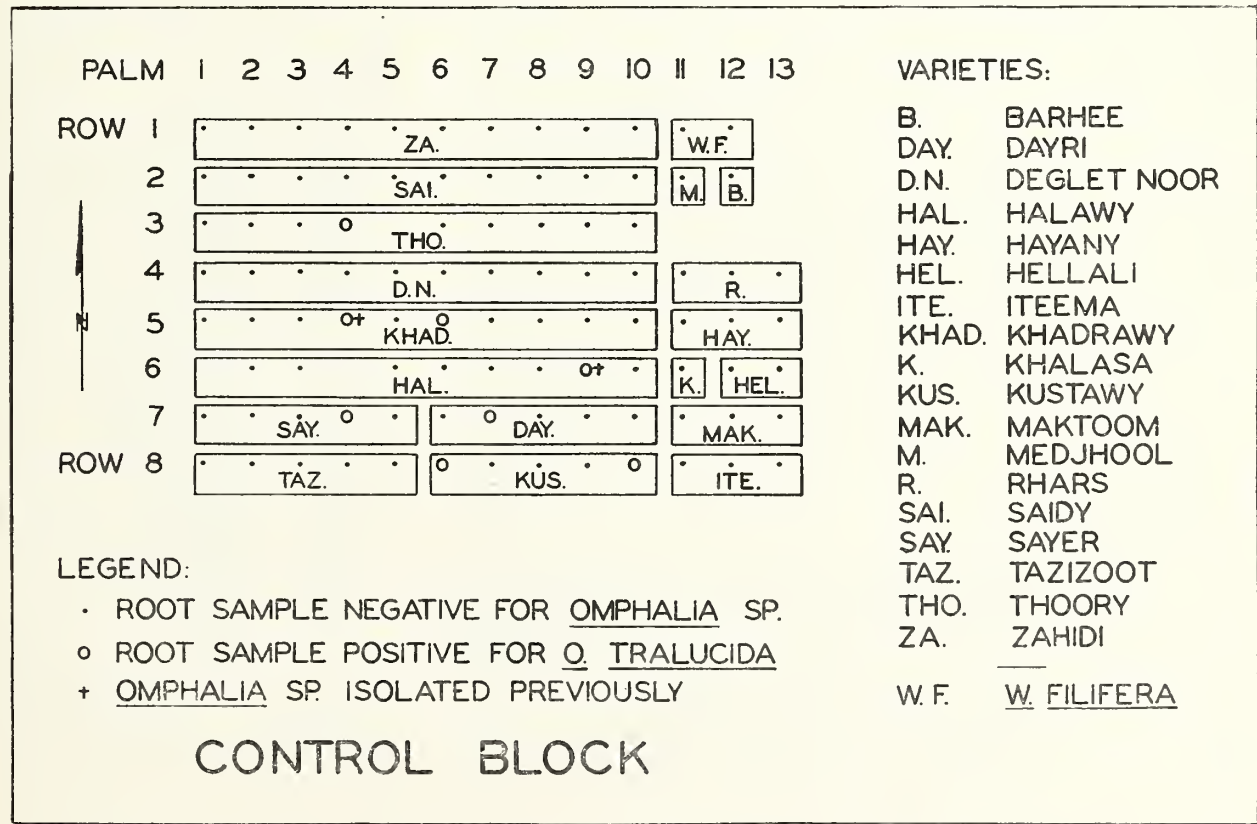
The experimental data presented

Table 1.—Number of Spathes and Mean Length* of Fruitstalks on Deglet Noor Date Palms, Mecca Plot, April 12, 1948.

Palm No.	Control Palms (Row 4)		Inoculated Palms (Row 12)	
	Number of Spathes	Mean Length of Fruitstalks (cm.)	Number of Spathes	Mean Length of Fruitstalks (cm.)
1	14	54	12	66
2	16	49	6	22
3	14	45	6	23
4	11	53	8	40
5	14	47	6	11
6	14	40	13	31
7	11	56	8	15
8	9	32	11	33
9	8	46	13	51
10	12	57	9	63
Total	123		92†	
Weighted mean		48		33

* Distance measured along fruitstalk from fiber line of subtending leaf base to first or proximal fruitstrand.

† Difference significant at the 5 per cent level, as shown by the "t" test (7).



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LEGEND:

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ROOT SAMPLE NEGATIVE FOR OMPHALIA SP.

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ROOT SAMPLE POSITIVE FOR O. TRALUCIDA

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OMPHALIA SP. ISOLATED PREVIOUSLY

VARIETIES:

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DAY.

DAYRI

D.N.

DEGLET NOOR

HAL.

HALAWY

HAY.

HAYANY

HEL.

HELLALI

ITE.

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KHAD.

KHADRAWY

K.

KHALASA

KUS.

KUSTAWY

MAK.

MAKTOOM

M.

MEDJHOOL

R.

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W. FILIFERA

CONTROL BLOCK

Fig. 3.—Plan of control block in date orchard at the Mecca plot, showing results of the survey for omphalia root rot, which was started in December, 1947.

Table 2.—Results of Omphalia Root Rot Survey in the Mecca Plot, 1947-48.

Variety of Date Palm, Phoenix dactylifera	CONTROL BLOCK						INOCULATED BLOCK					
	Palms		Primary Roots				Palms		Primary Roots			
	Total Number	Number Infected with Omphalia	Total Number	Mean Density*	Number	Necrotic Per cent	Total Number	Number Infected with Omphalia	Total Number	Mean Density*	Number	Necrotic Per cent
MAJOR VARIETIES												
Deglet Noor	10	0	649	1.27	4	0.62	10	6	529	0.82†	42	7.94†
Halawy	8	1	370	0.63	13	3.51	10	0	478	0.63	11	2.35
Khadrawy	10	2	590	1.13	11	1.86	10	1	662	1.06	14	2.12
Saidy	10	0	671	1.33	5	0.75	10	4	625	1.05	20	3.20
Thaory	9	1	564	1.28	12	2.13	8	3	530	1.52	23	4.34†
Zahidi	10	0	621	1.37	7	1.13	10	5	589	1.23	32	5.43†
MINOR VARIETIES												
Barhee	1	0	45	.....	1	2.22	1	1	65	.....	4	6.15
Dayri	5	1	244	0.78	12	4.92	5	1	297	0.86	10	3.37
Hayany	3	0	144	.....	0	0.00	3	2	180	.....	17	9.44
Helloli	2	0	99	.....	0	0.00	2	1	99	.....	10	10.10
Iteemo	3	0	190	.....	0	0.00	3	0	157	.....	2	1.27
Khalasa	1	0	32	.....	0	0.00	1	0	54	.....	0	0.00
Kustawy	5	2	208	0.50	3	1.44	5	0	280	0.82	0	0.00
Maktoom	3	0	197	.....	0	0.00	3	1	226	.....	1	0.38
Medjhoal	1	0	49	.....	0	0.00	1	0	39	.....	6	15.38
Rhars	3	0	177	.....	0	0.00	4	1	217	.....	8	3.69
Sayer	5	1	347	.....	3	0.86	2	2	186	.....	6	3.23
Tazizoot	5	0	260	0.83	6	2.31	5	0	239	0.59	1	0.42
Fan Palm‡	2	0	135	.....	1	0.74	2	0	128	.....	18	14.01

* Number of primary roots per centimeter of depth in 15-inch-square sampling hole.

† Difference significant at the 5 per cent level.

‡ Washingtonia filifera Wendl.

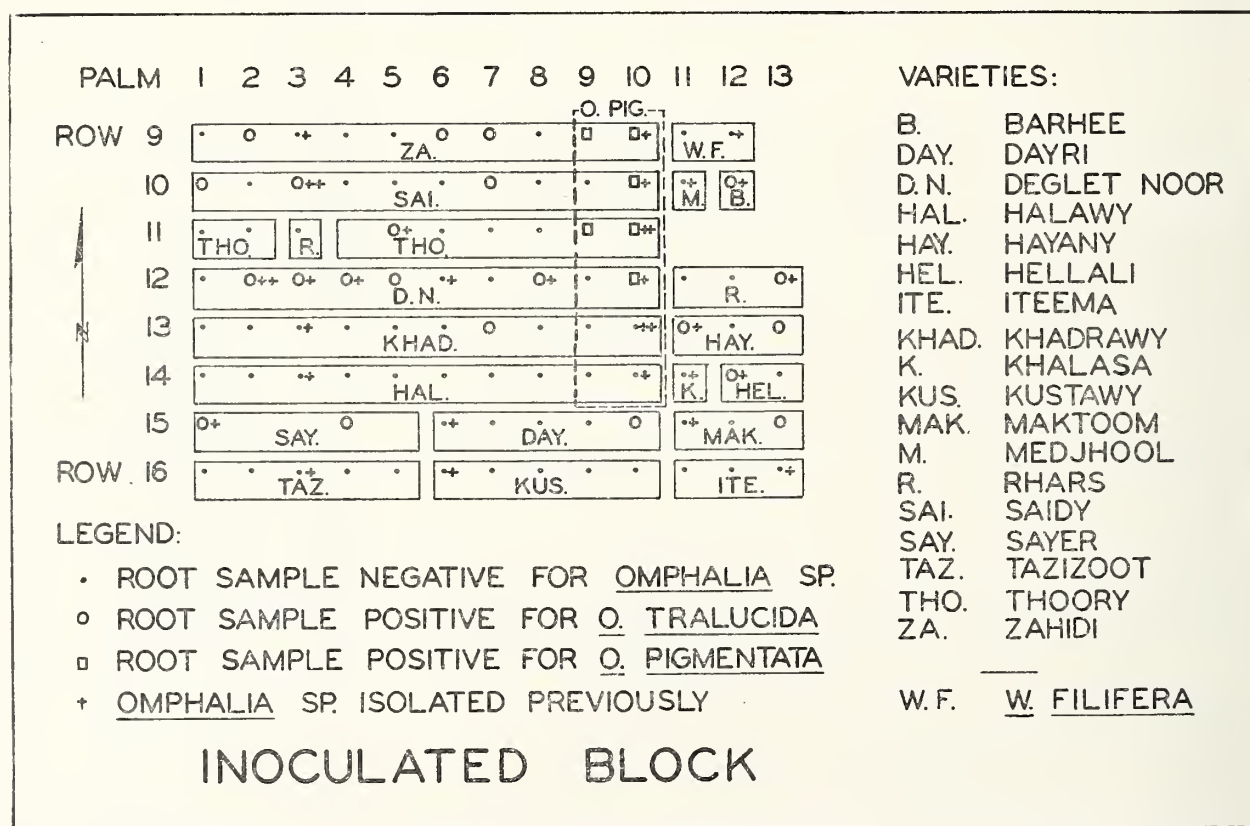


Fig. 4.—Plan of omphalia-inoculated block in date orchard at the Mecca plot, showing results of the survey for omphalia root rot, which was started in December, 1947.

here and in earlier papers (1, 2, 3) give some tentative indications of the relative susceptibility of our date varieties to omphalia root rot. All the 18 varieties represented at the Mecca plot are known to be somewhat susceptible, but some appear to be injured much more than others. Deglet Noor is considered to be the most susceptible; Iteema and Tazizoot are among the least susceptible. Since true disease resistance has not been demonstrated, the varieties have been divided into

palms originated in date orchards where omphalia root rot had been known for many years. Since *Omphalia* spp. are widely distributed in date orchards throughout the Coachella Valley (6) and the transmission of the disease on offshoots is well established (1), it is not surprising that these pathogens were inadvertently carried to the Mecca plot. It is improbable that these fungi were already present in the soil prior to the planting of this orchard, because the palms of the

to omphalia root rot resulting from artificial inoculation.

Summary

Progress is reported on an inoculation experiment with omphalia root rot in a 4-acre, 18-variety date orchard near Mecca, California.

Whereas the primary symptoms of the disease were observed in all 18 varieties within four months after inoculation (1938), the secondary symptoms first appeared in two Deglet Noor palms after six years (1944). Although less vigorous at first because of saline soil in part of the orchard, the Deglet Noor palms in the control block have grown nearly as much as those in the inoculated block and are now generally more vigorous.

Root samples taken during 1947 and 1948 from all palms in the orchard revealed that *Omphalia pigmentata* and *O. tralucida* were associated with root necrosis in most of the varieties, but that the Deglet Noor, Hayany, Hellali, Sayer, Thoori, and Zahidi varieties had sustained the greatest injury. These varieties are tentatively rated as susceptible to omphalia root rot. The Barhee, Dayri, Kustawy, Maktoom, Rhars, and Saidy varieties are tentatively rated as tolerant, and the Halawy, Iteema, Khadrawy, Khalasa, Medjhool, and Tazizoot varieties, as very tolerant.

Measurable differences between the inoculated and the control palms of the Deglet Noor variety indicate the development of both primary and secondary symptoms of omphalia root rot as the result of artificial inoculation.

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Table 3.—Relative Susceptibility of 18 Varieties of Date Palm to Omphalia Root Rot (Tentative Rating).

SUSCEPTIBLE	TOLERANT	VERY TOLERANT
Deglet Noor	Barhee	Halawy
Hayany	Dayri	Iteema
Hellali	Kustawy	Khadrawy
Sayer	Maktoom	Khalasa
Thoori	Rhars	Medjhool
Zahidi	Saidy	Tazizoot

three groups to indicate different degrees of susceptibility (table 3). The terms "tolerant" and "very tolerant," as used in this table, refer to the quality of enduring the disease process without experiencing serious injury.

Discussion

The root-sampling technique employed in this study gave much comparable data, but it revealed only a small part of the roots. The volume of the sampling hole was probably less than one thousandth of that occupied by the root system of the palm, although the concentration of roots in this space was relatively high. The lesions of omphalia root rot tend to be concentrated near the trunk (2) and are found most commonly on the north side (5). The root samples, therefore, while coming from the best location, were comparatively small and perhaps were not always typical of the average condition of the entire root system. Since the inoculations were made on the east and west sides of the trunk and the samples were taken from the north, there appears to be evidence that the pathogens had spread through undisturbed portions of the root system.

The finding of *Omphalia tralucida* in eight of the control palms of the Thoori, Khadrawy, Halawy, Sayer, Dayri, and Kustawy varieties seemed unfortunate for the experiment but was not unexpected because of the diverse sources from which the planting stock had been obtained. Five of these infected

susceptible Deglet Noor variety have remained healthy in the control block. The situation in the control block merely indicates what could have been expected in the south block if the palms in that part of the orchard had not been inoculated.

It is not supposed that all the necrotic roots on a palm were necessarily killed by omphalia root rot, since such roots are also found to some extent on noninfected palms. The direct comparison of the inoculated with the control palms at the Mecca plot indicates the differences which may be attributed to the artificial inoculation. In the Deglet Noor variety, for instance, the inoculated palms had on the average significantly more dead roots but significantly fewer total roots and spathes than the control palms. The inoculated palms were generally more vigorous than the others in 1938, but five of them are now visibly weaker. This change occurred in spite of the salty soil in which part of the control palms were grown. These Deglet Noor palms are of the same age; they were obtained from the same source and have been treated alike except for inoculation with omphalia. Although six of the inoculated palms are known to be diseased, none of the controls have shown evidence of infection, a fact also substantiated by KenKnight and Amling (6). Unless excess soil salinity is more favorable to date palms than we believe (4), the differences in these two groups of palms must be attributed

How Variations in Soil Moisture Affected Growth of Deglet Noor Date Palm Offshoots

By R. H. Hilgeman and J. R. Furr
U. S. Department of Agriculture¹

Considerable variation in the percentage of survival and in the amount of leaf growth made by different lots of date palm offshoots in the first season after planting has often been observed, even in carefully grown plantings where soil moisture conditions were relatively uniform.

Aldrich, Leach, and Dollins (1), in reporting the results of an offshoot planting experiment, state: "These Deglet Noor offshoots showed an unexpectedly high mortality that could not be correlated with size or vigor of the parent palms or with any environmental or culture factor other than small size of the offshoots."

It has, however, been observed both in the Old World and in this country that the percentage of survival of "hard," slow-growing offshoots cut from palms that had a scant water supply is often higher than that of rapidly growing "soft" offshoots cut from well-irrigated palms. This point is emphasized by Mason (2) in his discussion of date propagation in Egypt and the Sudan.

Such observations suggested that perhaps drought-hardening of the offshoots from palms with a poor water supply might be responsible for the superior survival value of such offshoots, and that the drought-hardened condition in the offshoots might be induced by subjecting the parent palms to a period of severe water deficit prior to cutting the offshoots.

Another factor generally believed to affect greatly both survival and growth of newly planted offshoots is the frequency of irrigation.

Aldrich et al. (1) found that, in an offshoot planting in pervious sand, greater leaf growth resulted from a 2- to 4-day irrigation interval than from a 7- to 10-day interval; but in a planting on an impervious soil where water stood on the soil surface for 3 to 4 days after each irrigation, both leaf growth and percentage of survival of offshoots were higher in plots irrigated every 14 days than in plots irrigated at 3- to 4-day intervals or at 7-day intervals.

The present investigation had two objectives. One was to determine what effect an extended period of drought prior to removal of the offshoots from the parent palms would have on survival and growth of the offshoots during the first season after planting; the other was to determine what effect variations in soil moisture conditions after planting would have on survival and growth of the offshoots.

Methods and Materials

Offshoots growing on a group of 48 Deglet Noor palms planted in 1942 at the U. S. Date Garden, Indio, California, were used for the experiment. Prior to the initiation of this experiment the parent palms had been grown with frequent irrigation and no fertilization. In October 1946 this block was subdivided into four areas, each area containing twelve palms. Irrigation water was withheld from two of these areas from October 30, 1946 until May 5, 1947. On the latter date they were irrigated sparingly. The remaining two areas were irrigated on December 12, January 3, February 7, March 14, April 11, and May 5. The rate of leaf elongation was measured on the two central palms in each group of twelve. The moisture content of the upper eight feet of soil was determined from oven-dried soil samples taken before and after irrigating.

Forty offshoots were cut, on May 22-23, from the parent palms in each of the two irrigation treatments. The lower leaves of the offshoots were removed, the tops cut back to about 36 inches above the fiber, and the extent of rooting and the weight of the offshoots recorded. Each group of 40 offshoots was classified by size into four subdivisions. One offshoot was then selected at random from

each size group to make up planting groups or replications of four offshoots each. The offshoots were planted ten feet apart in basins five feet in diameter, and were arranged in a randomized design to provide for two irrigation treatments after planting. Two weeks after planting the tops were wrapped with burlap.

All offshoots were given two heavy irrigations during and after planting on May 23. A second irrigation was applied to all offshoots on May 26. Thereafter, one half of the offshoots were irrigated Monday, Wednesday, and Friday of each week and the remaining half once each week until October. During October and November the interval was lengthened and in December the experiment was terminated. Soil moisture tension in the upper two feet of soil was measured with eight tensiometers. The relation between the soil moisture tension values and the soil moisture content expressed as percentage of the dry weight was determined. The soil temperatures at 18 inches below the surface at 4 locations were recorded at frequent intervals. The amount of leaf extension on the offshoots was measured at about monthly intervals until December. The data obtained were examined for statistical significance by analysis of variance.

The soil in which the parent palms and offshoots were grown is classified as Indio loam. The upper three to four feet of loam has a high water-holding capacity, but the 4- to 8-foot zone is fine sand of much lower field capacity. Roots are concentrated in the upper silty zone. The water-holding characteristics of the upper two feet of soil are shown in Table 1 by the moisture percentages at various tensions and at the wilting point.

Table 1. — Water-Holding Characteristics of Indio Loam Soil.

Depth (feet)	SOIL MOISTURE AT DIFFERENT TENSIONS (a)					Wilting Point (b)
	75 cm. (Percent.)	100 cm. (Percent.)	125 cm. (Percent.)	175 cm. (Percent.)	200 cm. (Percent.)	
0-1	30.5	27.0	24.0	20.5	19.0	3.5
1-2	31.0	28.0	25.0	21.5	20.0	4.5
Av.	30.8	27.5	24.5	21.5	19.5	4.0

(1) Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

(a) Soil moisture as percentage of dry weight of soil; tensions reported in centimeters of water.

(b) Wilting points obtained from field drying of soil in adjacent areas.

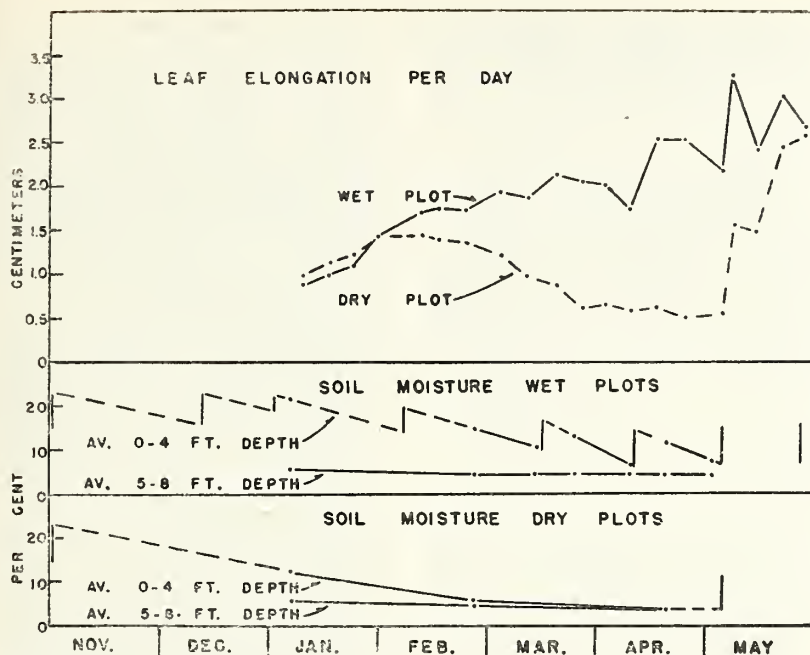


Figure 1.—Rate of leaf elongation and soil moisture conditions in wet and dry plots of parent palms prior to cutting offshoots. (In soil moisture curves, broken lines are assumed trends; unbroken lines connect observed values.)

Effect of Treatments of Parent Palms

The effect of changes in soil moisture upon the rate of leaf elongation of the parent palms is shown in Figure 1. In early February when the average percentage of soil moisture in the upper 4 feet of soil was about 9 percent, a reduction in the rate of leaf elongation in the dry plots occurred. The rate of growth gradually decreased during the spring until an average of only 0.5 cm. per day was reached. In comparison with the irrigated plots this amounted to only about 20 percent of the normal rate of growth. Following the light irrigation of May 5, a rapid increase in growth rate occurred.

Growth in the palms that were irrigated during the winter and spring was maintained at a relatively high level, though apparently not at the maximum possible rate. There were some fluctuations in the leaf growth rate of these palms in the spring months that seem to be related to variations in soil moisture. This suggests that they were subjected to slight water deficits for short periods.

Survival and Growth of Offshoots

The treatments given these offshoots did not have a significant effect upon their survival during the first six months after planting. Only four offshoots died. Each of these

was from a different parent palm, and death could not be related to irrigation treatment before or after cutting, to weight of offshoot, or to amount of roots at time of cutting.

The average amount of leaf elongation made by the offshoots as indicated by measurements at about monthly intervals, and the least differences between means required for significance at odds of 19:1 are shown in Figure 2.A. The soil temperatures at a depth of 18", which

was the average point of new root development, are shown in Figure 2.B (the average soil temperature of the moist plot is represented by the dotted line, that of the wet plot by the unbroken line). The frequency of irrigation and the ranges through which soil moisture tension fluctuated in the upper two feet of soil in the wet and moist plots are represented by the diagonal lines in Figure 2.C.

Leaf extension on the offshoots from the irrigated parent palms (Figure 2.A) was greater than that on the offshoots from the unirrigated parent palms from the time growth began to Nov. 4, when growth was slowed down by cool weather. These differences were significant at odds of 99:1.

The frequency of irrigation after planting the offshoots did not have as great effect as the treatments given the parent palms. Up to July 3 the triweekly irrigation had produced significantly greater leaf extension than the weekly treatment, at odds of 19:1. During the next 55-day period, the offshoots irrigated at weekly intervals began to grow more rapidly than the others. By Aug. 27 the plants irrigated at weekly intervals had more leaf growth than those irrigated 3 times a week. This trend continued throughout the remainder of the experiment.

Statistical analysis of the amounts of leaf elongation attained on Sept. 25 and on Nov. 4 shows that within the group of offshoots cut from irrigated parents the leaf extension made by the offshoots irrigated at weekly intervals was significantly greater than that made by those

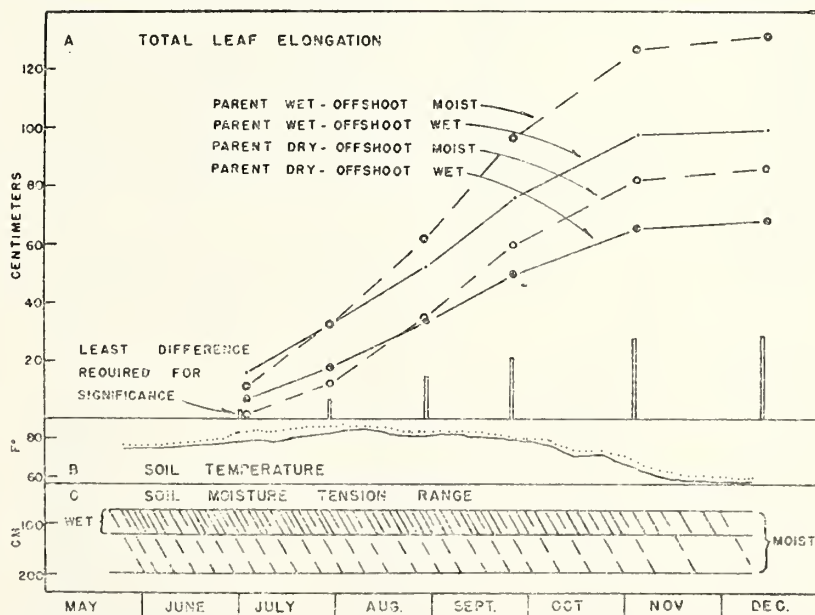


Figure 2.—Growth of new leaves on offshoots, soil temperature, and soil moisture tension after planting.

irrigated 3 times a week, by odds of 19:1.

Within the group of offshoots cut from parents subjected to drying, however, the difference in growth resulting from the irrigation treatments applied to the offshoots was not statistically significant.

The soil temperature curves (Figure 2,B) show that temperatures between 78° F. and 86° F. occurred between July 1 and Oct. 1. During November, when the soil temperature dropped below 60° F., little growth was made. The average temperatures in the moist plots were from 2° to 4° F. higher than those in the wet plots. Appreciable variation between different plots occurred, however, so the differences are not significant.

The soil moisture in the wet plots fluctuated between tension values of 75 and 125 centimeters of water, or 31 to 25 percent soil moisture (Figure 2,C). In the moist plots, the range was from 100 to 200 centimeters of water tension, or 27.5 to 19.5 percent soil moisture. Since the average wilting point of the upper 2 feet is about 4.0 percent, it is evident that even under the weekly irrigation schedule the soil moisture was maintained at high values. Since soil temperatures under the two irrigation treatments were not sufficiently different to explain the observed differences in growth, it appears probable that the reduced growth of the offshoots on the wet plots was caused by poor soil aeration. There was probably greater loss of nitrate by leaching in the

wet than in the moist plots. In early September, however, ammonium nitrate was applied to half of the plants in each treatment, and there was no response to fertilization by December, when the experiment was terminated.

To determine whether growth of the offshoots during the first season was related to size of the offshoot at planting, the coefficient of correlation between offshoot weight and leaf extension was calculated. This value ($r=0.18$) was not significant for this group, which had a weight range of 32 to 155 pounds. Aldrich et al. (1) also found no relation between size of offshoots at planting and growth made by offshoots within the size range 38 to 82 pounds.

All of the offshoots planted had developed roots before they were cut, but shoots with many roots made no better growth than those with few roots.

The results obtained in this investigation indicate that on moderately heavy soils, such as Indio loam, a satisfactory irrigation schedule for date offshoots during the first season after planting would be at 2- to 3-day intervals between applications of water for about a month after planting, with an increase of the interval thereafter to at least 7 days. Because the survival of offshoots was very high under all treatments, the results of this experiment shed no light on the possible causes of variation in offshoot survival.

Summary

The leaf growth of offshoots removed from palms previously subjected to a period of severe water deficit was significantly less than that of offshoots obtained from palms that were subjected to only slight water deficit. A high survival (95%) of all offshoots was obtained, with no significant differences due to treatment.

An irrigation interval of 2 or 3 days maintained soil moisture tensions between 75 and 125 centimeters of water and produced significantly greater leaf extension during the first 40 days after planting than an irrigation interval of 7 days, which allowed a 200 centimeter tension to develop. During the next 124 days, the growth rate changed so that at the end of the period more new growth was present on offshoots irrigated at 7-day intervals than on offshoots irrigated at 2- or 3-day intervals. This difference was statistically significant in only the group of offshoots from irrigated parent palms.

There was no correlation between the amount of leaf extension and the original weight of the offshoot within the weight range of 32 to 155 lbs.

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Growing Quality Fruit Pays Dividends

T. R. Brown, Grower

My talk deals with the subject of dividends back to growers. You might well ask what kind of dividends. It is because there are no dividends from date growing today that I am talking on the subject.

The period to be discussed is from 1942 to 1946 inclusive, that period in which date growing was a pleasant and profitable occupation. Before we turn to that period, however, let us consider for a few minutes some of the reasons why today's returns are unsatisfactory.

First is a factor over which we have little or no control, the cheap dollar, or in other words, the high cost of living. The January 15th index of the cost of living stood at the record high of 168.8, with the period 1935-39 as 100. The food index alone was 209.7, which means that the shopper takes home less than half the groceries for the same amount of money spent in 1935-39. This situation forces the consumer to concentrate upon the necessities of life and leaves little room in the average budget for our California specialty crops. Other products as well as dates are gathering dust on the grocers' shelves. The importation of foreign dates was reduced by the importers in 1947 to 20 million pounds from 48 million in 1946, and this smaller volume is moving slowly.

The loss of export sales following the war has materially affected dried fruit sales, and along with them our dates. Normally one-fourth to one-third of our dried fruits are exported. The warehouses of the Central valley are bulging with unsold figs, raisins and prunes. Our farmers and marketing organizations, along with the Europeans, are looking to the Marshall Plan for assistance.

Second: The reputation of the California date suffered during the period of high prices. Marketing standards were discarded in the gold rush and as a result the quality of our product no longer commands a premium over imported dates. We demand a high standard of quality in goods we buy and we should expect others to demand it of our product.

Third: We have had three successive years of mediocre or poor crops. These, together with few if any marketing regulations, have done little to enhance the reputation of our product. We can still sell good dates at a satisfactory price, but at the present time substandard dates do not return the

cost of growing to the farmer.

I am a member of a committee of our marketing organization that has as one of its jobs the improvement of quality. We have worked with the packing houses and with growers in an effort to put high quality dates on the market. My opinion after two years of work on that committee is that the improvement of quality is an industry as well as an individual problem.

From discussions with other growers it occurred to me that the grade out and returns from our garden have for several years been above the average in our organization. If proof could be offered to others that it pays to grow quality dates the benefits might be reflected in a general improvement in the industry.

My plan is to show the tonnage grown, the cost per acre and per pound, and the net returns per acre of our garden over a five year period from 1942 through 1946. Only nine acres of mature trees of our 23 acres will be used in this study. Other acreage is immature. I will then show costs and net returns based upon the average tonnage with the average grade out of the California Date Growers' Association, of which we are members. Our own growing costs will be used but adjusted to meet any difference in picking costs due to a difference in tonnage grown. I am assuming that our cost of operations is near the average of other members of the association. If the average cost is lower, and I hope it is, the average returns will be higher than shown on the charts. This assumption is the weak spot in this report. Our Association packs about six million pounds of Deglet Noor dates annually and offers a representative cross section of the industry for comparison.

Mr. W. W. Cook, president of the Association, agreed to furnish any data needed. The cooperation of

Mr. Cook and his assistants is greatly appreciated.

Seven charts will be shown. They tell the story much better than words.

Chart 1 is shown to emphasize the difference in cost of growing dates between the years of 1942 and 1947. The percent of change shows the decline in purchasing value of the dollar. It also shows the necessity of increased returns if the farmer is to survive.

The per cent of change is irregular and certain items need explaining. The cost of fertilizer has been kept constant by buying more commercial fertilizer and less manure per acre. Taxes have increased tremendously and will bear watching. They have reached a figure higher than the rental value of our land, with returns low as they are. In addition to the 333% increase shown, our acreage is also subject to an assessment of \$.004 per pound for the State Marketing Order. Applied to the 1947 crop, this amounts to an additional tax of \$39.66 an acre, all of which makes our taxes over 600% greater than 1942!

Tractor and hauling expenses have increased with increased tonnage, higher labor and supply costs, and more repairs on older equipment. Depreciation expenses in-

Chart 2.—Average Expenses per Acre—1942-46 inclusive.

Labor	\$375.32
Fertilizer	109.85
Water	52.33
Taxes	23.03
Tractor and Hauling	36.16
Twine and Paper	33.08
Depreciation	112.89
Other Expenses	107.81
TOTAL	\$850.47

Chart 1. — Expenses per Acre.

	1942	1947	% Change
Labor	\$ 160.47	\$ 505.81	+ 215
Fertilizer	121.33	119.05	— 2
Water	42.01	44.34	+ 5
Taxes	10.36	44.81	+ 333
Tractor and Hauling	13.44	61.19	+ 355
Twine and Paper	32.23	57.49	+ 78
Depreciation	38.21	150.64	+ 297
Other Expenses	18.87	143.76	+ 662
TOTAL	436.92	1127.09	+ 158

creased with added equipment and housing facilities. The increase in other expenses is largely due to throwing the cost of a shipment of ladders into expenses rather than capitalizing the expense.

Chart 2 needs little explanation. I am sure several of the expenses could be reduced. We made little effort to economize on growing costs while returns were high. Our average costs for the five year period

ferences is reflected in the returns per pound columns shown in succeeding charts.

Chart 4 briefly summarizes the tonnage, growing and packing cost, gross and net returns per pound and acre. Column one gives the year; column two, the net picked weight per acre; column three, the total growing cost per acre; column four, growing cost per pound; column five, packing cost per pound; col-

per acre (column three) are based upon our own costs per acre (column three Chart 4) with picking costs adjusted according to tonnage picked.

Chart 6 summarizes the information set forth in Charts 4 and 5. Our heavier average tonnage per acre for the period can in part be due to a difference in age of trees. Our trees were one-half nine and one-half ten years old in 1942. The average tonnage per acre of California Date Growers' Association members came from trees of miscellaneous ages. The cost per pound naturally decreases with increased tonnage produced. The premium obtained by our fruit is explained by Chart 3, since all fruit was sold through the same organization. A study of this chart would indicate that heavy production per acre of better than average fruit pays dividends.

The following chart has little relation to this study but is offered to show changes that have taken place in date growing since 1934. Columns one and two are the same as shown in Chart 6, but column three is a summary of the cost study made by Mr. Richardson and a number of date growers referred to earlier in the report.

Several comparisons in the above chart are interesting. First is the great increase in tonnage grown in the last few years as compared with the 1934-39 period. The average age of trees in the Richardson report was 10.6 years, an age closely paralleling that of our trees. I would attribute much of the increase to the work of Roy Nixon in his studies and reports of leaf and bunch management, and to the work of other scientists from the United States Experimental Garden

Chart 3.—Average Grade Out — 1942-46 Inclusive.

	% Brown	% Cal Date	% Difference
Fancy	18.3	4.5	+ 13.8
Choice and Standard	27.4	40.4	— 13.
No. 1 Dry	28.3	18.1	+ 10.2
Substandard	9.8	16.6	— 6.8
Spots	4.9	3.9	+ 1.
Culls	7.0	9.8	— 2.8
Shrinkage	4.3	6.9	— 2.6

were 2.7 greater than those reported in a comprehensive cost study of date growing representing 124.6 acres of mature trees compiled for the years 1934-1939 by H. B. Richardson, Assistant County Agent.

Chart 3 shows the average grade out of our garden over the five year period, the average of the California Date Growers' Association, and the per cent of difference. It is interesting to note that if the fruit from our garden falls in the natural grades the tendency seems to be for a greater per cent of it to reach the Fancy grade and less in the Choice grade than the fruit graded by the Association. Likewise, more of our dry fruit seems to be in the No. 1 dry grade rather than Substandard. The effects of these dif-

umn six, total cost per pound; column seven, gross returns per pound; column eight, net returns per pound; and column nine, net returns per acre.

Gross returns per pound, (column seven) was found by dividing column one (picked weight per acre) into total returns per acre. Returns from field culls and from unpollinated fruit were excluded.

Chart 5 is in the same form as Chart 4. It is based upon the average picked weight per acre of members of the California Date Growers' Association. Gross returns to growers are based upon the average price per pound, on picked weight before shrinkage or packing house culls are deducted, to conform with column two in Chart 4. Growing costs

Chart 4. — Cost and Returns Per Acre — Browns'.

1	2 Lb. per acre	3 Growing cost per acre	4 Growing cost per lb.	5 Packing cost per lb.	6 Total cost per lb.	7 Gross returns per lb.	8 Net returns per lb.	9 Net returns per acre
1942	8758	\$ 436.90	.0498	.034	.0838	.1744	.0906	\$ 793.47
1943	12957	892.16	.0688	.026	.0948	.3072	.2124	2752.07
1944	12536	1024.78	.0817	.03	.1117	.3404	.2286	2866.48
1945	4689	1091.79	.2328	.0475	.2814	.1765	-.1038	- 486.91
1946	18427	1212.27	.0657	.0289	.0947	.1397	.0449	828.32

Chart 5. — Cost and Returns Per Acre — Cal Date Average.

1	2 Lb. per acre	3 Growing cost per acre	4 Growing cost per lb.	5 Packing cost per lb.	6 Total cost per lb.	7 Gross returns per lb.	8 Net returns per lb.	9 Net returns per acre
1942	7485.8	\$ 444.18	.0593	.0153	.0746	.1381	.0634	\$ 475.25
1943	8551.4	848.10	.0991	.021	.1201	.2645	.1443	1234.25
1944	10806.5	1007.48	.0932	.0281	.1213	.256	.1346	1454.77
1945	4741.9	1092.45	.2303	.0475	.2779	.1326	-.1456	- 690.71
1946	10468.	1112.78	.1063	.0289	.1352	.1336	-.0016	- 17.27

and the University of California through the Riverside Citrus Experiment Station. We also owe Mr. Richardson much for his help in improvement of growing methods. His group meetings and demonstrations in cultural practices and his sound advice have paid us big dividends.

Growing costs in the last five years were nearly three times that of the 1934-39 period. Based on the same tonnage, costs would have been over five times as high. Higher returns in the later period more than offset the difference. After comparing net returns per acre this year, it looks like history was beginning to repeat itself. Returns per pound are slipping back to pre-war days but costs are constantly rising. The solution of our problem calls for sound thinking on our part.

Production figures, costs and returns given in this report were used as a basis for income tax purposes. They are quite personal and I apolo-

gize for laying them before you. I do so only to point out that to make date growing profitable we must emphasize both tonnage and quality.

Good marketing years will return and growers who keep their gardens in peak conditions will profit thereby.

Chart 6. — Cost and Returns Per Acre, Five Year Average—1942-1946.

	Brown	Cal Date
Average pounds per acre	11473.4	8410.4
Average cost per pound *	.1119	.13009
Average returns per pound	.2297	.19235
Net profit per pound	.1177	.0623
Net profit per acre	\$ 1150.63	\$ 523.99

*—Includes packing.

Chart 7. — Five Year Average 1942-46 Versus Six Year Average 1934-39.

	Brown	1934-39
Average pounds per acre	11473.4	5827.
Average cost per pound	.1119	.0445
Average returns per pound	.2297	.0476
Net profit per pound	.1177	.0031
Average net profit per acre	\$ 1150.63	\$ 18.06

The Effect of Picking Practice Upon Date Packing Cost

Wm. W. Cook, Grower and Packer

The effect of picking practices upon packing-house costs can best be discussed by considering how these costs are affected by certain types of fruit which a grower may deliver to a packer. To do this, it is assumed that an efficient packer can handle a pound of good field run dates for two and three quarters cents (.0275). This figure is intended to cover all direct and overhead packing-house expense except the actual cost of half lugs or other containers. It is in line with cost records of the California Date Growers Association. It is assumed that marketable dry dates will be hydrated with a gain in weight of ten percent, and that the cost of hydration is offset by the value of this added weight. Therefore, no credit is made for gain in weight and no cost is allowed for hydration.

If a grower delivers a lot of 1,000 pounds of good field run dates which is reduced by a 3% shrinkage and the removal of 2% culls, the grower has a net pack-out of 950 pounds. The packer has spent \$27.50 to prepare them for packing. If the culls have a value of 1½c, the sum of thirty cents can be deducted from cost, leaving a net packing-house expenditure of \$27.20 to produce 950 lbs. or a cost of .0286 per packed pound. (Cost of container to be added, which is about one cent per pound for bulk).

We now compare the results of handling three other lots of 1,000 pounds each. For reference, we will call the lot just described, which produced a pack-out of 950 pounds at a cost of .0286 per pound, lot "A". The second lot considered will be designated as lot "B". This lot is delivered by a grower who operates his ranch well and does a good job of picking. He also has only 2% culls. But lot "B" is found to contain 50% high moisture fruit, part green and part ripe but too wet to pack. It is found that this 500 pounds (half of the total of 1,000 lbs.) must be placed on trays. Records show that an added cost of one-half cent per pound is incurred on this 500 pounds, or \$2.50. In addition, an added shrinkage takes place. In this case, the dates on trays are found to average 35% moisture. The finished product has an average moisture content of 24%. This is accomplished by the removal of 72 pounds of water, which means that the normal 3% shrink

is increased to 10.2% of the total delivered weight. The pack-out is 1000 lbs. less 102 lbs. shrink and 20 lbs. culls, or a net of 878 pounds. Cost per packed pound is .0338.

Basic Cost on 1,000 lbs.	\$27.50
Extra Cost for Tray- ing 500 lbs.	2.50
	\$30.00
Less: Value 20 lbs Culls	.30
	\$29.70

Lot "C" is similar to lot "A" except that an inspection sample shows 25% culls, of which half are interior defects (mold and insect infestation inside the date). The packer debates as to his ability to remove the culls. Since the infestation is under 15%, he decides to grade the lot even though he knows he will spend at least twenty dollars (2c per lb. on the entire lot) as an additional grading expense over and above the basic cost of \$27.50. He also knows that the best grading job possible will result in the culling of an additional ten percent of good dates. It is impossible to grade out dates with interior defects without removing quite a number of good dates that are suspected of containing interior defects. The result of the handling of lot "C" is 350 pounds of culls, 19½ pounds shrink, and a net pack-out of 630½ pounds. Cost per packed pound is .0670.

Basic Cost of 1,000 lbs.	\$27.50
Extra Cost Due Interior Defects	20.00
	\$47.50
Less: Value 350 lbs. culls	5.25
	\$42.25

Lot "D" is one that contains both

high moisture fruit and culls. It is a combination of the two situations set forth for lots "B" and "C". The only variation is that only 40% of the lot must be placed on trays due to the high percentage of culls thrown out on the first grading. Also, the tray fruit must be regraded carefully, as interior defects are found in the trayed fruit. This adds another two cents a pound to the cost of the pack-out from the tray fruit. The shrinkage on 400 pounds (reduced from 35% to 24% moisture) is 58 pounds. The shrinkage on the total lot is 77½ pounds. The total culled is again 350 pounds. The culls also lost moisture, so the recovery from culls is a cent and a half a pound on 300 pounds. The net pack-out is only 572½ pounds. The cost per packed pound is .0905.

Basic Cost on 1,000 lbs.	\$27.50
Extra Cost Due Interior Defects	20.00
Extra Cost Traying 400 Pounds	2.00
Extra Regrading 342 lbs. Tray Output	6.84
	\$56.34
Less: Value 300 lbs. Culls	4.50
	\$51.84

The examples given are arbitrary but they are typical of lots received by packers. Even lot "D" can not be considered as a horrible example, as lots were received in 1946 which had only a few dates not requiring drying and which contained over 50% culls. Cost figures used are conservative in all cases. In this regard, attention is called to the fact that if harvesting cost were included, the increased cost per packed pound on low pack-out lots would become even more alarming. The following table summarizes the study of the four lots discussed above:

Results of Handling Four Types of Lots

Lot	Type Fruit	Del. Pounds	Total Culls & Shrink	Packed Pounds	*Total Net Cost	Cost per Deliv. lb.	Cost per Packd. lb.
A	2% Cull, Tree-ripe	1,000	50	950	\$27.20	.0272	.0286
B	2% Cull, Wet Fruit	1,000	122	878	29.70	.0297	.0338
C	25% Cull, Tree-ripe	1,000	369½	630½	42.25	.0423	.0670
D	25% Cull, wet fruit	1,000	427½	572½	51.84	.0518	.0905

* Cost is exclusive of container.

Conclusions

The picking and delivery of culls is the most serious obstacle to packing-house efficiency. Green dates and high moisture content dates add to cost. It is possible that better quality in pack-out will offset this higher cost, provided excessive culls are not present. The grower of high moisture dates must be particularly careful to avoid culls.

MEANS OF AVOIDING CULLS:

1. Pick as frequently as possible.
2. Use best practices for reduction of mold and insect infestation in field. (See previous Date Institute Reports on this subject.)
3. Deliver dates to packing-house promptly. Green dates

develop mold and fermentation when held unfumigated. Insect infestation is an even greater danger.

4. Grower should ask packer to notify him immediately upon receipt of a lot containing a high cull percentage. Upon receipt of such notice he should take action to correct picking operation.

Acidity In Relation To Quality In The Date Fruit

G. L. Rygg, U. S. Department of Agriculture, Pomona, Calif.

The 1947 crop of Deglet Noor dates in California was characterized by having an unusually high percentage of fruit in the dry grades. It is not unusual for as much as 30 percent of the crop to be so dry as to require hydration, but 80 to 90 percent, or more, of the 1947 crop was so dry that it had to be hydrated or macerated before it could be marketed. The reason for such a high percentage of dry dates is not known, but the condition is thought to be related in some way to the weather conditions during the growing season.

Because of the firm texture and somewhat unattractive appearance dry grades of Deglet Noor dates are looked upon with disfavor by the trade, in spite of their nutty flavor which is very agreeable to many. This characteristic flavor tends to be destroyed by the usual methods of hydration.

The sugar content of the dry grades of dates, expressed as percentage of total dry matter, is as high as that of the better grades, but the amount occurring in the form of sucrose is usually higher in the dry grades. These facts have been reported previously at this Institute by Sinclair, Bartholomew, and Bliss (1), and are further substantiated by the data given below in table 1. The high proportion of sucrose and the accompanying low content of reducing sugars is undoubtedly related to the early drying of the dates on the palms before the usual amount of inversion which accompanies ripening has taken place. A high proportion of the sugar in all Deglet Noor dates is in the form of sucrose before ripening begins.

Consistent compositional differences between the dry grades of dates and the more desirable fancy and choice grades have not previously been reported. There appears, however, to be a consistent difference in the degree of acidity in

Table 1.—Sugar Content of Deglet Noor Dates of Various Commercial Grades.

GRADE	Total sugar in percentage of dry weight	Reducing sugars in percentage of total sugar
Choice	78.6	47
Standard	77.7	47
Waxy tip	77.4	37
No. 1	78.8	27
No. 2 for hydration....	78.0	24
No. 2 for maceration....	78.1	24

these grades. Dates are normally low in acid, but apparently the amount present and the condition in which it occurs play highly important roles in the ripening processes. The effect is presumably brought about by the influence the acid exerts on the activity of the enzymes concerned, some of which are sensitive to small differences in this respect. Measurement of the active acidity, or hydrogen-ion concentration, in more than 200 individual date fruits has shown a consistent difference between dates of high and low quality; that is, fancy or choice as compared with dry grades, the highest quality being associated with the lowest hydrogen-ion concentration (highest pH value).

The method used consisted of grinding the date flesh in a food chopper and mixing it with a small quantity of water, usually one part of water to one part of date paste by weight. The hydrogen-ion concentration of this material was determined with a Beckman glass electrode pH meter. The addition of water was made to assure good contact with the electrodes in all instances. The effect of adding water was to increase the pH readings slightly (lower the hydrogen-ion concentration), but the positions of different lots of dates relative to one another remained the same.

Hydrogen-ion concentration, or active acidity, is expressed on a pH scale. This scale may seem somewhat confusing but is actually easy to follow. A value of 7 represents a condition in which the acidity and alkalinity are balanced. This condition is found in pure water. A value of 6 represents a condition ten times as acid as 7, and a value of 5 is ten times as acid as 6, and so on.

The trend of the pH values found is indicated by the following ranges:

41 of 54 fancy were within the range	pH 6.0 to 6.9
21 of 25 standard were within the range	pH 5.2 to 5.7
24 of 30 No. 1 were within the range	pH 5.2 to 5.9
65 of 69 No. 2 were within the range	pH 4.9 to 5.7
10 of 11 "rubbery" were within the range	pH 5.0 to 5.2

"Rubbery" refers to a certain quality characterized by reddish color, spongy texture, and a corrugated surface. The flavor of such dates is satisfactory but they are very difficult to hydrate because of resist-

ance of the flesh to breaking down.

The acidities found in high grade Deglet Noor dates indicate a pH value of 6.0 or higher. The values found in the dry grades show much more acidity than has been reported previously for this variety (2), but no fruits of the dry grades were included in the material used in previous tests. The highest acidity found in an individual fruit was pH 3.93. Grayish colored dry dates that had the appearance of having suffered from mite injury had a hydrogen-ion concentration in the same range as that of good quality fruit. High quality dates of the soft type have hydrogen-ion concentrations in the same range as a good grade of Deglet Noor, pH values of 6.3 to 6.8 having been found.

These results suggest that high acidity interferes with the normal ripening processes by making the conditions such that some of the hydrolytic enzymes are unable to perform their normal functions before the fruits have dried to an extent that will of itself inhibit enzymatic action. On the assumption that the normal ripening processes are slowed down or stopped by the relatively high acidity, several attempts have been made on harvested dates to lower the acidity and thus promote softening of the flesh. These attempts have met with only partial success.

Dry grades of dates were held in air-tight vessels over water containing varying concentrations of ammonia. Others were immersed in such solutions for varying lengths of time at the suggestion of Dr. D. G. Clark of Cornell University. Still more severe treatments consisted in immersing dates in ammonia solutions in a suction flask, evacuating the flask, then releasing the negative pressure and pouring off the surplus solution. By this infiltration method the ammonia solution was forced into the flesh. The best texture resulted from the infiltration method in which the 5 percent concentration of a 28 percent ammonium hydroxide solution was used, or the equivalent of about 1.4 percent pure ammonia dissolved in water. The hydrogen-ion concentration (active acidity) of the date flesh was decreased from about pH 5.60 to a final value of pH 6.18 to 6.71. Dates treated in this way and held at room temperature for 1 to 2 weeks developed good texture and had excellent flavor. A serious objection, however, was that they developed an objectionable dark color, prob-

ably from the action of the alkali on the tannins present in the flesh or from the favorable effect which a relatively alkaline reaction has on the browning reaction. The possibility remains that a suitable combination of reagent, concentration, temperature, and time can be found which will make possible the satisfactory softening of many dry dates with the retention of the characteristic flavor which is partly destroyed by the high temperatures that must otherwise be used. The time likely to be needed for this treatment would probably make such a process

unattractive to commercial operators.

No encouragement has been found in the results from the use of carbon dioxide, acetic acid, or hydrochloric acid in attempting to soften dry, hard dates. On the basis of the above discussion this should not be surprising, since all of these reagents increase the acidity of a tissue that is already too acid for normal ripening to take place.

An incidental result from the ammonia treatment was the prevention of fermentation even under conditions of high humidity over periods

of at least several weeks. No noticeable microbiological deterioration occurred in dates subjected to 1.4 percent ammonia in water, even after prolonged holding.

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Storage Humidity For Dates

G. L. Rygg, U. S. Department of Agriculture, Pomona, Calif.

Accurate information on the correct relative humidity for dates in storage has long been sought by the cold storage industry. Only approximate values have been available and they have been very general in nature. It should be obvious that dates dried to different levels of moisture content require different storage humidities in order that they will not gain or lose moisture in storage, but the correct humidity to obtain this condition is not so obvious.

The information contained in this paper was developed for the purpose of determining the correct storage humidity for dates of any common variety containing any given percentage of moisture over a range likely to be found in practice.

The method used consisted of enclosing single dates in a small space and determining the relative humidity of the air within that space with an Aminco-Dunmore electric hygrometer¹, after equilibrium with the date had been attained. After the appropriate relative humidity was found the moisture content of each date was found by slicing and then drying the date two days at 65°C. (149°F.) in a vacuum oven.

The results obtained at 75°F. are shown in figures 1 and 2. Figure 1 gives the humidities found to be in equilibrium with Deglet Noor dates with moisture contents from about 12 to 30 percent. The points are scattered along the curve, the position of which was calculated according to standard statistical procedure.

In addition to Deglet Noor, the relation between moisture content and storage humidity was determined for seven other standard varieties and a black seedling of the soft-date type. These were Khadrawy, Halawy, Barhee, Maktom, Medjhoel, Saidy, and Zahidi. The results, covering a range in moisture content from about 15 to 40 percent, are shown in figure 2. The values for these varieties fit a curve which is shifted slightly to the right from the position of the curve for Deglet Noor. The values for all the varieties fit on the same curve. It is to be noted that the Zahidi fits the curve for the soft varieties rather than the one for Deglet Noor. This variety is intermediate between the two general classes with respect to invert sugar and sucrose.

A comparison of the two curves shows that the moisture content of soft or invert-sugar dates is higher

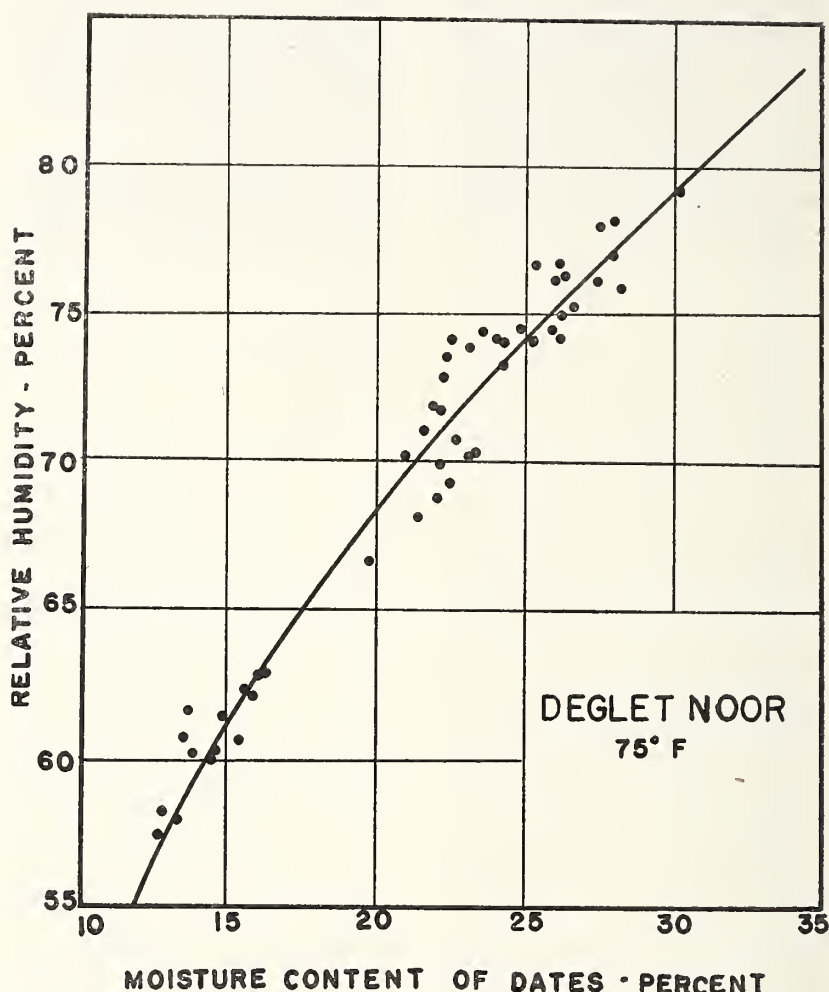


Figure 1. — Relative humidity in equilibrium with Deglet Noor dates with different moisture contents at a temperature of 75 degrees F.

at equilibrium than that of Deglet Noor when the two types are held in the same storage room. This is in agreement with observations made by those who have had experience in storing dates.

Temperature has a pronounced effect on the value of the relative humidity at which a given lot of dates should be stored. This effect is illustrated in figure 3.

Very moist dates (40 percent moisture) require a relative humidity which is 11 percent higher at 32 degrees F. than at 75 degrees. In very dry dates (9 percent moisture) it was found that the corresponding difference in relative humidity at the two temperatures was 17 percent. With these figures as the extreme values, intermediate values have been interpolated and plotted in figure 3, because for practical

purposes it may be assumed that the temperature effect is a linear one. The proper storage humidity for any temperature between 32 and 75 degrees can be determined by the use of figure 3 and either figure 1 or 2, depending on the variety.

To determine the proper storage humidity one must first learn the moisture content of the dates to be stored. With this information at hand the next step is to consult figure 1 for Deglet Noor dates and figure 2 for the soft varieties in order to find the relative humidity that applies at 75 degrees. Then locate the appropriate relative humidity on the right hand side of figure 3 and follow the diagonal line toward the left until the proper vertical temperature line is reached. From this point the horizontal line is followed to either side of the chart where the

(1) Dunmore, Francis W. An improved electric hygrometer. J. Research Natl. Bur. Standards 23: 701-714. Dec. 1939.

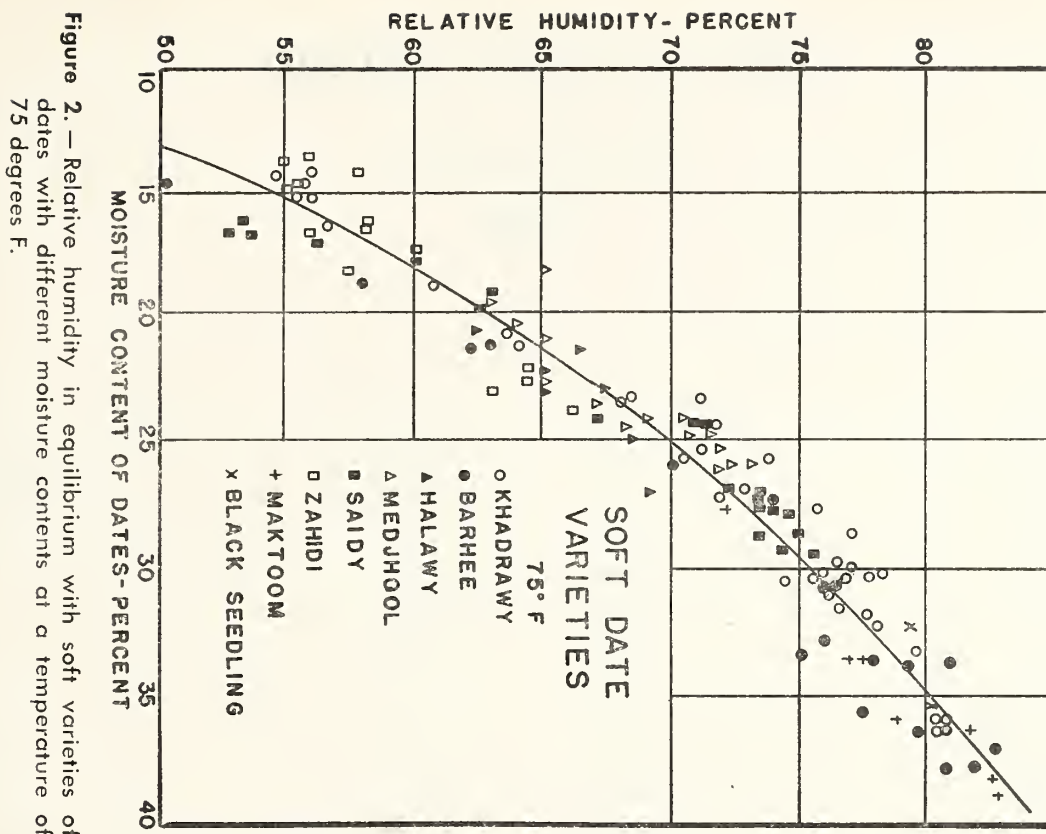


Figure 2.—Relative humidity in equilibrium with soft varieties of dates with different moisture contents at a temperature of 75 degrees F.

correct relative humidity for that temperature is found. An example will demonstrate the procedure. Suppose a lot of Deglet Noor dates has a moisture content of 25 percent. Reference to figure 1 shows

that the correct storage humidity at 75 degrees is close to 75 percent. With this information one finds on consulting figure 3 that the correct relative humidity at 40 degrees is 85 percent. At 32 degrees a relative hu-

midity of 87 percent is required.

For temperatures much below 32 degrees control of the storage humidity for dates is not ordinarily very important since the rate of gain or loss in moisture is very slow.

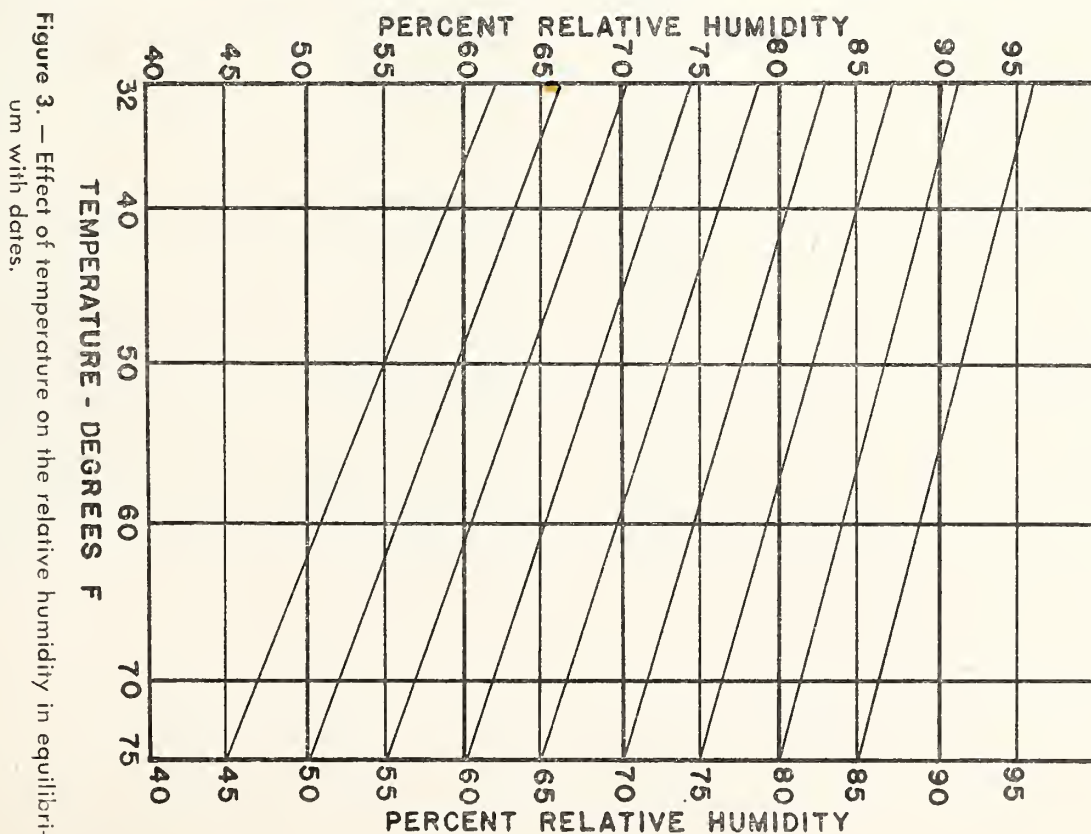


Figure 3.—Effect of temperature on the relative humidity in equilibrium with dates.

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